Entangled

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Entangled

An Archaeology of the Relationships between Humans and Things

Ian Hodder

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Epigraph

Fly, Fly, Fly
wings of hope
soaring out of history
clichéd words from beautiful images
forced out words sucked from a place of quiet loneliness

Beauty comes in so many forms
freedom, hope, identity
sitting in this chair listening to the sounds
listening, touching, smelling the images

What would light be if there was no darkness?
would we really be falling if there was no ground to hit.
what about soaring?
If all you can do is fall how do you land in the right place
Broken statues, jumping off ledges
–
I am a different person when I walk in different directions

(from the writings and poems of Kyle Hodder-Hastorf)

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I will always associate this book with Kyle. He was not impressed when I first told him of its theme, but I have labored to make an argument in which he might have seen some merit. He is at rest but deeply, sorely missed.

Chapter 1

Thinking About Things Differently

Approaches to Things

If we look at some of the ways in which things have been approached in the humanities and social sciences we find a bewildering array from the more semiotic to the more material (Candlin and Guins 2009). Recent approaches, in a strand reaching back to Appadurai's *Social Life of Things* (1986), have explored the many social dimensions of things. Thus, in 'materiality' studies (e.g. Keane 2003b, Meskell 2005a, Miller, 2005b, Pels 1998) the focus is often on the ways things and society co-produce each other (see Chapter 2). Anthropologist Nicholas Thomas (1991) uncovers the role of material objects in the entanglements of colonialism and empire. Bill Brown in his book on *A Sense of Things* and in his development of 'thing theory' examines how things are given new meanings in late 19th century literature (Brown 2001; 2003). Other influential work by Latour (1993) tries to break away from subject-object dualisms and argues for a symmetrical approach to humans and non-humans. Philosophers such as Ihde (1999) explore the ways in which materials and instruments enter into the scientific hermeneutic process (for a different approach in philosophy see Wylie 2002).

As we work through the chapters in this book we will see that a recurrent criticism of these diverse approaches to things is that despite their protestations to the contrary, they could look more closely at things themselves. The approaches, for the most part, explore what things can do for humans in society. So each approach or study takes one aspect of a thing – its symbolism or the labor needed to produce it or its shiny attractiveness or its efficiency in killing an animal or its material links to actor networks – and shows how that particular aspect is made use of, or even

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Figure 1.1 A piano at the Mesolithic site of Lepenski Vir (Source: Giovanni Caselli).

constitutes society or what it means to be human. Things are broken up in this way. Each approach or study takes what it wants of things.

As social actors we tend to see things in ego-centered ways, in terms of what they can do for us. We hardly look at them. Our interests are in the effects for us, aesthetic, social, scientific, psychological and so on. But every now and then we actually look at the thing itself, as a whole object, a thing in its own right. We explore its grain, feel its weight, note its color in different lights, marvel at its balance and delicate detail. Of course our interest remains self-serving, and often nostalgic, but there is sometimes a moment of realization that in order to understand the thing we have to look harder, anew, deeper, more fully.

In Figure 1.1 a reconstruction of the hunter-gatherer site of Lepenski Vir is shown. This is based on archaeological remains of floor plans and animal bone and stone tool distributions on this 8000 year old Mesolithic site on the Danube excavated by Srejovic (1972). There is an overall scene in which humans go about their business surrounded by appropriate houses and objects. The things in this image and on the archaeological site are used to build a picture of a way of life – of hunters-gatherers-fishers in a settlement or village. In such an image the things are props for a way of life. They allow us a glimpse of a lost society – they do that for us. But our interest in the end is the humans and their society. The things are only there as backdrop. They make a specific form of human society possible.

But we can do something subversive – put in an object that does not fit. This is absurd. A concert piano? Suddenly the things, including the piano, force us to look at them more carefully. Why is a piano so absurdly out of place in Lepenski Vir? We look at the piano. It looks like those played in symphony halls, it requires highly specialized skills to play, it is based on a specific western 12-tonal system, it uses a cast iron frame and high-tension wire that only became available in the Industrial Revolution. The grand piano needs symphony halls, it needs years of practice by trained musicians, it needs the system of tones in music, it needs factories able to pour precision iron. The people in the image could not understand, hear, make a grand piano. They did not have the factories, ships to import the materials, the imperial reach, the organization of labor, or the ideas about music that made the piano possible.

So, subversively and subtly, the focus has changed from how things make society possible to the thing itself and its multiple connections. The gaze shifts to look more closely, harder at the thing, to explore how society and thing are co-entangled. That is the shift that I want to try to make in this book.

Let us start with some themes about things that I will return to time and again.

Themes About Things

Things are Not Isolated

The example of the piano in the Mesolithic draws attention to the ways in which things are inter-dependent. Certainly human-made artifacts are not isolated because they by definition depend on humans. Thoughts, football games, institutions are all things that depend on a wider social context and many relationships between things are constructed by human purpose. A house wall needs a roof if the human need for shelter is to be fulfilled, a bath needs a plug, a sail needs a mast. Material things fit into each other so that if I place a large squared and flattened stone on another it will stay there, at least long enough to make a wall. Things stick to each other. They can be tied together. Soap needs water, cooked food needs fire, iron ore needs a furnace if I wish to make metal.

As Preda (1999) points out in relation to philosophy and sociology of science studies, what makes an object relevant and useful in relation to the production of scientific knowledge in the laboratory is not just the object itself, but the knowledge involved in recognizing an object for what it is and how it can be used. A transfer pipette is not just an object in itself (Preda 1999: 350) – it also incorporates knowledge about measurement procedures, the physical properties of liquids, about the relationship between pressure and volume, etc. Some of this knowledge may not be known by a user who may rely on tacit knowledge about how to apply pressure in using the pipette.

But what of natural things – are they not isolated? It is in fact difficult to identify things not affected by humans – a separate natural category. Since humans have been in existence we have affected the world on a large scale (Roberts 1998) so all things are to some degree human-made artifacts. But even without humans, things are part of inter-related eco-systems. Plants and animals need the sun, they need oxygen. Animals need other animals in symbiotic or predator-prey relationships. They need salt and water. Things need to absorb other things – air, food, water – and to excrete them. A fish fits in water but not in air. Or a river needs a bank to flow through.

Things are Not Inert

The notion that things are stable and fixed, at least inanimate material things, is widely assumed. Thus: 'it is this durability which gives the things of the world their relative independence from men who produced and use them, their "objectivity" which makes them withstand, "stand against" and endure, at least for a time, the voracious needs and wants of their living makers and users. From this viewpoint, the things of the world have the function of stabilizing human life, and their objectivity lies in the fact that … (we) can retrieve their sameness' (Arendt 1958: 137; for similar statements see Latour 2005; Olsen 2010: 139). Other thinkers, philosophers and artists have from time to time become fascinated by a different view. The Futurist art movement at the start of the 20th century was intrigued by the bicycle because it depended on movement and speed for it to be a bicycle. They were fascinated by things in movement. In the 'Technical Manifesto' of Futurist painters published in 1910, Marinetti and others stated that 'all things move, all things run, all things are rapidly changing'.

Even what we call inanimate things have charges, weights. They are attracted to each other or repulse each other. They have force and velocity, heat and viscosity. They fall down, rise up. They form into clouds and then disappear into thin air. They dry out, get wet, change appearance and consistency. Of course this is true of gases and liquids. Water takes new forms as it flows over my moving hands beneath the tap. Solids too transform. Organic solids breathe, eat, create energy, defecate. They rot and decay. Even the hardest of inorganic solids change – rocks erode into sands that are sorted and carried in water down to the seas. Archaeologists know that even obsidian is not inert – its surface hydrates at a steady rate. At different scales, matter has a vibrant vitality (Bennett 2010).

So there are only flows of matter, energy and information (Deleuze and Guattari 2004: 377, Ingold, 2010). Thus when we as individual organic entities come into being, matter with various physical-chemical characteristics is brought together – atoms, enzymes, cells, DNA and so on. For a time this flow of materials constitutes an organic entity we call a human, animal or plant body which then dies, dissipates into other forms of physical-chemical-biological matter. So things are really just

stages in the process of the transformation of matter. The same is true of energy; a fire in the grate is a concentration of energy that then dissipates. Information too takes various forms as it flows through voice, onto the TV screen, back into words that may get written down and so on. Or the same word may mean different things in different contexts.

The lack of inertness is linked to the lack of isolation. Things fall apart because of chemical or biological attack or the forces of gravity. Things move because they have been given velocity by something else, and the gravity of the earth is a force that pulls objects towards it. Artifacts are a particular class of things – those made by humans. They in particular are not isolated, needing human attention and care as we will see in Chapter 4.

Things Endure over Different Temporalities

Of course, this fluidity of things is not how they appear to us. Objects and materials can endure over time spans considerably greater than individual human experience. A sound (unless recorded) is very short lived, as are the firings in the brain, or the glance of an animal. A rain cloud is always transforming, never fixed. Humans, animals and plants have longer duration, but many things have temporalities far beyond human lives – the geological flows that produce mountain ranges, the flows of ice that produce valley systems, the gradual decay of a stone wall or the decay of a steel girder or a Palaeolithic hand-axe.

These temporalities differ radically. The earth has existed for 4.54 billion years; the plates of the earth move at a rate of 1 to 10 cms per year, causing unpredictable sudden shudders as they slide against each other. I have excavated at archaeological sites that have residues of human activity from 300 000 years ago. The wheel was invented 6000 years ago. We are all indebted to these past histories. Our biologies, our technologies, societies and cultures, our psychologies and cognition all flow from the past, often the deep past. Equally what we do today and every day, the fleeting moments when we discard a plastic bag or drive a car, produce residues, land-fill and greenhouse gases that will endure as problems for future generations.

So to some degree Arendt was right that we depend on an apparent durability of things. Objects do objectively stand up against our transient and uncertain lives, and our daily traffic counts on this stability, and yet at other scales things are always changing and moving.

Things Often Appear as Non-things

The Mesolithic piano example is reminiscent of the children's game in which we have to recognize anachronisms within a picture. The game is hard because we are not used to search through things in a picture in this way. We tend to take things

around us for granted. In Chapter 2 I will discuss theories about the non-discursive nature of much of our relationships with things. Some things are so omni-present that we stop seeing them, they become background or frame or medium.

Some types of things are designed to be invisible or unnoticed such as preservatives in foods or nips and tucks on the body. Window panes are designed to be looked through rather than to be looked at, unless one is a window cleaner. Another glass that we look through is a television screen. The TV is arguably one of the most transformative objects of the 20th century, and yet in our homes, as we watch our favorite programs, the TV itself becomes unnoticed. In fact we might even baulk at calling a TV a 'thing', since it is just the medium through which we see images. Unless we are TV repair mechanics, the box itself is of little interest and blurs into the background.

Marc Augé (1995) has written of airports as non-things or non-places – locations that we pass through, that seem the same wherever we are, that act as backdrop only. Danny Miller (1987) has discussed how much material culture acts as a frame round a picture – it provides a setting but has little meaning associated with it. It acts as a background cue for behavior.

The Forgetness of Things

It is because we take things for granted, often not focusing on them, that we fail to notice the characteristics of things that I have outlined above. We fail to see that things are connected to and dependent on other things. We do not recognize that they are not inert. And we forget they have temporalities different from ours, until those temporalities intrude in on us, causing us to take action.

There is a spatial and temporal forgetting of the unstable connections of things. A car appears to us as a car. We are taken in by the fact that the car has a perceptual boundary we can see or feel. It appears isolated, an object that is stable. But in fact the car is connected to the tarmac – indeed to a whole network of roads and road management systems that make the car possible. An American car is connected to mines in northern Minnesota from where the iron ore to make the steel frame of the car was obtained (Ryan and Durning 1997). It is connected to the Detroit assembly plant where it was painted by robots and workers. It is connected to oil fields in Iraq over which Western and Middle East powers have fought for the last century. But we forget all these spatial connections that make the car possible. They become invisible to us, at least until the Gulf States raise the price of oil so that we have to pay more at the pumps.

The same can be said of temporal connections. Take the example of my wrist watch. This has spatial connections that produced the leather band, the glass cover and the metal mechanical parts. But the wrist watch is also the product of millennia of change in temporal schemes. My watch tells the date. The yearly calendar was first fixed by Julius Caesar – trying to wrest power

from religious leaders who controlled a variable time. This Julian calendar was replaced by a Gregorian one – that established our current 12 months and the start of the year on January 1. More of these connections of the wrist watch will be explored in Chapter 5. But for the moment I can say that I am linked to Julius Caesar directly through my watch. And yet for most of the time we ignore these histories – or the even deeper history of the origin of the wheel that makes the watch mechanism possible (see Chapter 4).

Does it matter that in our daily lives we forget the spatial and temporal connectedness of things? Maybe not, but it is only recently that we have been made aware of the sweatshop conditions and exploitative labor relations that lie behind many of the goods we take for granted, or the destruction of elephant populations caused by the ivory trade. These distant effects of our fascination with things are increasingly drawn to our attention. And historically my watch has been made possible by the builders of empires and global systems of trade, and the fact that I can use my watch today continues to depend on this rich heritage of power and domination. I cannot unilaterally decide that it is 4.15 on January 6th 3924, when 'in fact' I can see on my computer screen that it is 10.47 on April 8th 2010.

What Is a Thing?

I have already used the word thing to refer to a great variety of entities – clouds, pianos, thoughts, clocks, sounds, bodies, molecules, institutions, ball games – as well as the more everyday items that fill our daily lives. So one aspect of the term 'thing' is that it is incredibly general. One colloquial use of the word 'thing' is that we often say 'that thing' when its name has momentarily escaped from us and it merely exists for us as something. Or we talk of someone whose name we cannot remember as 'thingy' or 'thingummyjig'. So here we are focusing on very basic aspects of entities – that they exist as contained and definable. Words, thoughts, institutions, events and materials have in common that, at least for the shortest of temporal moments, they exist as contained entities defined in a certain way. They create bundles of presence or duration in the continual flows of matter, energy and information. Just by having duration and presence we say they are things.

So a thing is an entity that has presence by which I mean it has a configuration that endures, however briefly. But this is also true of all entities and objects. I have been using the word 'thing' so far, but why not use the word 'object'? The word 'object' derives from the idea of throwing in the way. We are more likely to use the word object for things that are relatively stable in form – so while we might call a cloud a thing, we might be less likely to call it an object, though it can be an object of study. Anything can be an object of thought. So in many ways the terms 'thing' and 'object' overlap. The term 'object' is very tied up in a long history which opposes subject and object, mind and matter, self and other. It connotes an

objectifying approach in which material matter is analyzed, codified and caught in disciplinary discourse. While I will return to the notion that things do indeed have an existence that 'gets in the way' or 'objects', I want to start from a different position that explores the ways that entities connect to each other and to humans. The term 'thing' is more appropriate for such an approach.

We have seen that things pull together flows and relations into various configurations, whether the things are molecules and atoms, or whether they are books and computers, or whether they are institutions like schools and societies. For a period of time matter, energy and information are brought together into a heterogeneous bundle. Things assemble. We have seen that things are not isolated. It is in their connections, and in their flows into other forms, that their thingness resides.

In a series of papers published in English in a 1971 volume, Martin Heidegger deals directly with thingness. In a chapter called 'The thing' he considers a jug. He suggests that 'the jug remains a vessel whether we represent it in our minds or not' (1971: 167). In this book I shall say that the very existence of the jug can be described by saying it is an entity. Heidegger notes that the jug has been produced from the earth so that the material it has been made from 'has been brought to a stand' (1971: 167). Since the jug stands up against us it can be described as an object. So an object is something we contemplate as distant from us and set up against us. We shall see in Chapter 2 that Heidegger talks of this type of object as present-at-hand. Particularly when objects break down, we come to notice them and have to deal with them, fix them. When a scientist explores a jug to see what it is made of and what it was used for, it becomes an object of study, something distanced and particular.

But for Heidegger there is an aspect of the jug that is not captured by describing it as an entity or an object. The jug takes what is poured into it, and then pours the liquid out. The water and wine come from a rock spring or from rain or from the grape growing in the earth. The pouring out can quench thirst for humans or be a libation to the gods. So the jug connects humans, gods, earth and sky. It is this 'gathering' that makes the jug a thing. Heidegger refers to Old High German in which a thing means a gathering to deliberate on a matter under discussion. The jug, as thing, gathers together for a moment humans, gods, earth and sky.

Elsewhere in the same book, Heidegger provides other examples of things. Thus a bridge can be seen as gathering the two banks of a stream in relation to each other, and it gathers people that cross the bridge, it gathers people and carts into town or workers into the fields (1971: 151–2). The bridge as thing can be explored in terms of its usefulness, its functionality in bringing different components together. In this book I will focus on how things bring humans and non-humans together in heterogeneous mixes.

So things bring people and other things together. A good example is what happens when two people buy a house together. Perhaps each owns a share of the house. The two people may or may not be married to each other, but by buying a house together

they are brought together with each other and with the house itself, and the house and its maintenance are caught up (in a way that I shall describe in Chapter 5 as entanglement) with them. Thus if the house springs a leak in the roof, the two have to fix it in order to maintain the house as livable, and to protect their financial investment. They put their money, their savings into the house, and they borrow money from other people to buy the house – so if the property loses value through leaks and bad maintenance they may have to pay money back to the lender. So they are in a relation of debt to the lender. And they are tied to each other through the house – it becomes more difficult to separate or divorce, and the other person's behavior becomes of great interest and weight – will she or he behave in such a way as to undermine the value of the house, or in such a way as to put a strain on the relationship so that the house might have to be sold … and so on. So the thing ties people together, and into relations of dominance and subordination (e.g. with lenders).

We often talk of doing science 'objectively', when we reduce bias and explore the object in a distanced and disinterested way. To do this we have to separate the jug, measure it, categorize it, break it up into its components. It becomes an object of study, isolated and compared. Such analysis is a stage in the exploration of things. But such a stage of study needs to be situated within a broader approach that connects objects, that explores their existence as things. In this latter sense the focus is on the complex ways in which a thing such as a house gathers humans and non-humans, links together for a moment matter, energy and information in useful ways.

Humans and Things

I have so far talked of humans and things. But surely humans are things also? If things are just temporary bundles of matter, energy and information, it must also be possible to say that humans are just bundles of biochemical processes, flows of blood and nerves and cells temporarily coalesced into an entity that is thoroughly dependent on and connected to air, water, food and so on. This is not to oppose body and mind, since the mind too is a thing made of complex neural firings and associations closely linked to an external world of cultural information. As we shall see in later chapters, the mind is an embodied and distributed process. It is, like any other thing, highly connected, and not inert.

But if a human is a thing, it is a thing of a particular kind, one that has developed a very large and complex nervous system, body and mind thoroughly dependent on other things to exist. In Chapter 2 I will describe some of this dependence. In the same way that all living things depend on sunlight, air or water, soil and minerals, so too all sentient beings depend on things to bring their sentience into being. Humans are particularly dependent because their embodied nervous systems need activation by cultural and environmental cues. We can, in a thought experiment,

imagine a human growing up deprived of all external stimuli. Young children severely deprived of stimuli often have difficulties in developing beyond very restricted functional abilities (Joseph 1999). But in our thought experiment, imagine a growing child suspended (but with no strings) in darkness, without sound, food, water, without things and people. Imagine that this child could not even touch and explore its own body. If it was possible to keep such a being alive, my argument is that it would have no thought, no feeling – it would not develop as a human. Similarly, I will follow others in arguing in Chapter 7 that humans would never have evolved without things.

So in this book I justify the separation of humans as a particular type of thing because I am interested in how the human dependence on things leads to an entanglement between humans and things that has implications for the ways in which we have evolved and for the ways in which we live in societies today.

Knowing Things

This book aims to look at the relationships between humans and things from the point of view of things. This is a shift from the idea of a thing as something that people construct, make, use, discard, represent with and so on. In all these more traditional approaches to things, it is the human and the social that come first. It is the human use of things that is assumed to be the aim of research. But my attempt in this book is to follow the many others who have recently tried to get away from the one-sidedness of the utilitarian or semiotic approaches to things (Boivin 2008, Latour 1993, Renfrew 2004). The shift from objects to things is comparable to the shifts from discourses on environment to landscape, from space to place, from time to temporality (Lucas 2005; Tilley 1994), but the aim is to go further and explore the things, landscapes, places, temporalities themselves, to see human-thing relationships from the point of view of the things.

But I have skipped over an important problem. I have talked of objects and things as entities. The discussion above has assumed that once an entity has been defined – a jug, bridge or house for example – then it can be explored as a distinct object or as a connected thing. But how is the entity defined in the first place? If things are always connected, then how can we discern what the underlying entities are – where do we draw the boundaries that identify an entity as contained?

Heidegger uses the example of a jug. The boundaries of a jug are fairly clear – it is something one can pick up, move around. It has a clear coherence as it stands alone. But broken into sherds, at times ground into small flecks lost in the soil and dispersed through refuse in an archaeological site, where is the entity now? Is it the dispersed jug or the individual sherd? If the latter, what of the paint of the sherd that has come off and eroded into the soil? There are also categorization problems at a higher level. Perhaps the jug is part of a set of objects. Perhaps the jug comes

with tray and cup, so that the 'entity' could be argued to be the broader set of objects.

This problem is particularly acute in relation to transient things like sounds or sights that cannot easily be held, turned around, identified as distinct entities. Sounds or sights may form into words and sentences or into pictures and memories, but their boundaries as distinct entities are often difficult to determine. Similarly, it can be argued that the operational chains that produce artifacts are continuous sequences, arbitrarily divided up into actions, gestures, objects and residues.

When I look at the things around me on my desk, then it seems clear that they are all objectively distinct entities. I can pick them up, handle them, move them around. I perceive them as distinct and they have each their own life histories. And yet, looking more closely I see that the lamp is plugged into the wall. The phone has two cables attached to it. The computer is plugged into electric circuits and broad-band cables as well as wireless energy and information that hums around me. I look on the floor and there is a mass of wiring and plugs that leads off into the wall. We shall return to the 'front-back' aspect of things – that things often appear neat and distinct when you look at them from in front, but behind the scenes there are pipes, ducts, cables, refuse bins, coal bunkers, oil tanks hidden away at the back, or beneath the ground, or in the roof. All the connections of things are often hidden away. This is why I had to make the point earlier in this chapter that things are not isolated, are not inert.

So given the connectiveness of things, how can we define an entity as a bounded essence? Where do we draw the objective boundaries around a thing? Is my computer just the unplugged processor box? Or is it also the connections that allow it to work? Clearly it may be useful as an unconnected box to, say a designer, interested in making a style or fashion statement. But for me it is only useful if it computes – which means it needs its connections to work. So how I define an entity depends on its use as a thing. It is not the case that one starts with objective entities and then explores their thingness. Rather the identification of entities and things goes hand in hand. The jug is a coherent entity because of the way it is taken up and used. To be useful it has to have a void into which liquid can be poured and it has to have a spout to pour from. Its separate existence as an entity is tied to its use as a thing. Similarly with the computer. For me the entity is tied up with the fact that I want it to work, to search the Web. So the entity is more than the processor box; it includes the screen and keyboard. It is also the wires and cables that connect these parts to make a whole entity that works. It is also the global flows of energy and information that make my turning on the computer and searching the Web possible. At another level, we might say that the computer is made of parts, such as the keyboard, screen, mouse, processor. These different parts will be defined as separate entities depending on use. If the processor works but the display screen does not, then I will get the screen fixed and will enter into a discourse with shops and technicians to make

this entity work. And so on. Given the different purposes of our interactions with the computer we can divide it into ever smaller, or larger, entities – in each case linked to some purpose or interest.

Things seem 'out there' as entities 'in themselves', but how humans identify, perceive and categorize things is linked to the uses they have of them. The different ways that humans claim to 'know' about things and make them useful lead to different ways of being connected to other things. We might use the example of oracle bones in China as an example (Keightley 1985). These were pieces of turtle bone underside (plastron) that were used for divination in the Shang dynasty (also ox scapulae and tortoise carapaces were used). At that time, the bones were brought into connection with a particular suite of objects and humans including blood used to anoint the bone and the royal elite for whom and by whom the divinations were made. The bones were heated and cracked and then inspected by divination specialists who then wrote on the bones themselves, along the cracks. By the 19th century AD they had taken on very different roles. Treated as dragon bones they were dug up and crushed to make medicines. But right at the end of the century, they were first gazed on in a new way, when the Chinese scholar Wang Yirong made a connection between the ink markings on the turtle bones and the script on ancient Chinese bronzes. This scholarly discovery set off a chain reaction leading to large-scale looting and trade in the oracle bones. These bones, then, have been 'known' from many different perspectives, including the modern archaeological and linguistic. In each case, from the point of view of the bones, these different ways of knowing are not just abstract philosophical reflections – they involve the bones very differently in practical social and material contexts; they link the bones to different things.

Similarly, archaeologists today claim to know past objects in a variety of different ways. Some argue for cross-cultural comparison of objective data. Others argue for contextualized interpretations of local meanings. Still others argue that the phenomenological experiences of past actors can be reconstructed (see Johnson, 2010 for a summary of these different perspectives). We will be exploring many of these perspectives in the course of this book. But for the moment we can recognize that from the point of view of the thing, these different perspectives have the effect of creating different links with other things and humans. An archaeologist taking an objectivist or positivist stance will often focus on measurement, quantification and will bring the thing in relation to calipers, computers and comparative examples from across the globe. A more hermeneutic perspective will bring the thing in detailed relation to the objects with which it was found and into localized cultural codes and practices. These oppositions are here overdrawn, since in practice most archaeologists mix and match between different approaches and perspectives (Hodder 1999 , Johnson 2010). But my point remains – that from the point of view of the thing, the different epistemologies result in being embedded in different collections of things.

What makes things possible epistemologically in archaeology are sieves, microscopes, light refractors – but also different intellectual gazes. On an archaeological

site an object (such as a small piece of crushed turtle bone or a small fragment of a jug) will not be discovered as a thing if the archaeologist uses a sieve/screen mesh size larger than the object. So, things come about and come to be known because of a heterogeneous mix of humans and things. As a thing goes through its life history it finds itself brought into different relations with things and humans as a result of the different epistemologies that make it possible. Being known as a thing can either increase the duration of a thing (for example when the oracle bone is protected in a museum) or hasten its flow into other things (as when the oracle bone is digested as medicine). Similarly, different ways of archaeological knowing can lead to protection (through state legislation) or destruction (as in destructive analytical sampling).

As a thing goes through its life history its existence as a separate entity changes – at times dispersed into soil, at other times reconstructed from fragments. The presence of an entity depends on its use as a thing in relation to other things. This is true at all stages along its life history from original use to the use made of it by archaeologists in their interpretive endeavors. Knowing the existence of an entity is linked to the use of the entity as thing. From this it follows that consideration of thingness is as relevant to epistemological debate as it is to understanding social process.

Conclusion: The Objectness of Things

So I have argued that entities (bounded essences) and objects (that stand up against humans) can only be known by humans through their character as things (that gather humans and other things into heterogeneous mixes). So, from such a perspective, we 'make' things.

But to take this stand will not allow us adequately to achieve the goal of looking at human-thing relations from the point of view of things. As we shall see in the following chapters, in many ways things make us. There is an objectness, a stand-in-the-wayness to things that resists, that forms, that entraps and entangles. It is true that all the objects on my desk are connected to other things and that how I look at them depends on their use to me. But it is also true that they have lives that follow their own paths. The light in the lamp flickers and dies. The wind blows the paper onto the floor. I cannot get the phone to work because a wire in the headset has become loose. The water in the jug containing flowers evaporates and the flowers droop and die. I am drawn into things and their lives. I have to fix things, call the electrician, replenish the jug, go out and buy more flowers. I have to keep peddling uphill, fill the gas tank in the car, eat food when I get hungry.

Heidegger discusses a jug that is useful to humans. But he also describes how the jug is made from earth, how its stands on its own, how it holds water, how it quenches thirst. So the pot does things for humans, acts as a delegate (Latour

1992), seems to have agency (Gell 1998) and we will return to these ideas. But many of these approaches do not scrutinize the jug as a material object. They say little of the different types of clays and temper that make a jug able to hold water. They say little about how the burnishing of the pot surface works to make the fabric more water-tight. They say little about how some types of pot fabric and pot firings would gradually lead to leaks in the jug so that it could not function, or how some jug handles or forms of handle attachment would not have the strength to hold a jug full of water (Schiffer 1999).

There are thus numerous aspects of the material jug that stand in the way, that force themselves on human action. The thingness of the jug includes its object character. The challenge in the chapters that follow is to return to the objectness of things without jettisoning the gains that have been made in understanding things as closely tied to humans and their ways of knowing. In very general terms much recent work on material culture, materiality, object agency, landscape has allowed us to see the complex ways in which humans depend on things. And I will summarize this work in Chapter 2. But we need then to move on to consider the ways in which the objectness of things can be re-integrated into our discourses about things. We can look at entities as 'things' that assemble humans and non-humans together, or as 'objects' that are thrown in front of our thought, that oppose us. The challenge in this book is to integrate these two perspectives, to explore how the objectness of things contributes to the ways things assemble us, and to examine how our dependence on things includes the desire to be shorn of them.

There are engineering aspects to the jug. We need to understand physics and chemistry to see how it works. We need biology to understand how the flowers in the jug can be nourished. Most recent work on materiality, material culture, things derives from the social sciences and humanities. But if we are to consider things more fully we need also to integrate the natural sciences – and in archaeology to integrate archaeometry into theoretical debate. Over the next chapters I will move towards the idea of entanglement as a bridging concept.

Chapter 2
Humans Depend on Things

My background image for this chapter is of a mature student I was once teaching in a course on materiality. He told me how he had owned an old Harley Davidson motorbike that was in a sorry state of disrepair and neglect. At the time he was very depressed and unable to hold down a job. Putting the bike back together again became a project. Gradually, as he refurbished and polished it, he found that he was putting himself back together. He found he was reassembling both the bike and himself in tandem. This may have been an IKEA approach to depression, but he said it worked.

In reference to the discussion in Chapter 1, I will use the word 'thing' in this and the following chapters largely to refer to solid entities made or used by humans. I will return to a consideration of non-solid things in Chapter 10.

It has become a truism in archaeology, anthropology and the social sciences and humanities very broadly to recognize a 'return to things' over recent years (Candlin and Guins 2009, Domanska 2006, Preda 1999), in contrast to the earlier focus on representation, and in contrast to the long scholarly tradition that separated subject from object, mind from matter. The work of the scholar of American literature Bill Brown and his call for 'thing theory' were mentioned in the last chapter. The philosopher Don Ihde's (1999) 'material hermeneutics' denies the opposition between positivism and hermeneutics. For him things show themselves through technologies and machines. His material hermeneutics describes how the story of the 'Iceman' Ötzi (Fowler 2001) is based on technical instruments. The instruments shape the way we see Ötzi, so their role is hermeneutic. A similar point regarding the history of science has been made by Shapin and Schaffer (1985) in their work on the air-pump used in experiments by Boyle. Like the microscope and the telescope, the pump allowed new things to be seen. The air pump that created

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a vacuum in which experiments could be undertaken was 'a means of intellectual production' (Shapin and Schaffer 1985: 26). Preda (1999) provides other examples in the social sciences such as the work of Latour and Haraway. Numerous different perspectives have converged on some version of the idea that subject and object, mind and matter, human and thing co-constitute each other. In these different approaches it is accepted that human existence and human social life depend on material things.

In archaeology this shift from a focus on representation and a 'return to things' has been noted by numerous authors (for example, Thomas 1999, Barrett 1994, Preucel 2006) and has been well summarized by Olsen (2010) and Boivin (2008; see also Johnson 2010). The importance of symbol and sign in archaeology was explored through the application of structuralist and post-structuralist theories (Hodder and Hutson 2003, Johnson 2010). Within these frameworks the arbitrary nature of the sign was taken for granted. Since the relationship between signifier and signified was seen as conventional and arbitrary, constructivist perspectives were foregrounded, and subject and object, mind and matter were thoroughly disconnected. It soon became apparent, however, that most material symbols have meanings that are in some way indexical or iconic – in other words there is some link between signifier, signified and lived context (Preucel 2006). The way was open for approaches that explored the sensuous, the experiential, materiality and phenomenology.

A broad consensus about a 'return' has been reached in archaeology via different though interconnected routes. For example, there has been influence from Heidegger on archaeologists such as Thomas (1999) and Olsen (2010); the University College London school of material culture studies derived from a line of thought from Hegel and Marx onwards has been very influential in archaeology (Miller 1987); Bruno Latour's notion of a symmetry between humans and things and Actor Network Theory are having impact in the discipline (Webmoor and Witmore 2008); cognitive archaeology, influenced by neuro-science and evolutionary psychology (DeMarrais, Gosden and Renfrew 2004: 1) describes 'thought and practical activity going forward together' and discusses the 'extended mind' (see also Boivin 2008 and Knappett 2005). In Behavioral Archaeology there is focus on the mixing of people and things in behavioral chains (Skibo and Schiffer 2009) and in evolutionary archaeology there is increasingly influence from the Dual-Inheritance view of co-evolution between biology and culture (Richerson and Boyd 2005).

So we can say with some confidence that there would be general agreement in archaeology, as well as in related disciplines, with the idea that humans and human social life depend on things. We can say that we humans depend on things as technologies, that we depend on things as tools to feed us, to keep us warm, to forge social relations in exchange, to worship. Many would accept that as humans we have evolved with certain physical and cognitive capacities because of our dependence on things. It would also be widely acceptable to say that our perceptions and

our notions of desire, anger, love are always to some degree of or for something, including other persons. Similarly, at least if one takes an interactionist view (Jordan 2009a), much thought may be impossible without something to think of, and certainly memory is closely tied to material mnemonics.

In trying to summarize all the wide range of work that explores human dependence on things in one chapter, I recognize that I am trying to do too much. My intention is to note this work and the very thorough way in which it suggests that humans appear dependent. Rather than exploring all the research in its fullness, I am concerned at this stage simply to establish the multiple ways in which it can now be demonstrated that human existence depends on things. In the chapters that follow I want to take this dependence for granted and move on to the implications. It is the other aspects of the book that I see as more challenging and on which I wish to spend more time. I also wish in this chapter to point to what seems to me to be a gap in many studies of the human dependence on things. There is rarely an adequate account of the objective materials of things and their connections. The 'return to things' in the humanities and social sciences has not quite made it to the things themselves. It is this gap that will lead us on to the chapters in the rest of the book.

Dependence: Some Introductory Concepts

Before turning to a discussion of some of the main approaches that have dominated recent accounts of the human dependence on things, I wish to introduce some further concepts and themes that underpin my discussion in this book. These are the term 'depend' itself, and various forms or levels of dependence, but I shall focus in particular on the ways in which humans go towards and identify with things while at the same time trying to shrug off, deny or forget the identification and dependence.

Forms of Dependence

I shall distinguish two forms of dependence in this book. The first and more general focus on dependence (and for the plural I shall use dependences) recognizes that the human use of things is enabling. Human use of things allows humans to be, live, socialize, eat, think. I use the term dependence here and in the following chapters in the sense of 'reliance on'. But the word also has another inflection, as in the phrase 'it depends'. The dependence that I seek to explore involves both reliance and contingency. Human being depends on things, both in the sense of relying on things and in the sense of being contingent on the particular things relied upon. This historical dependence will play a larger role in my account later in this book. For the moment my focus is on how human reliance

on things is enabling and productive. But dependence also often leads to a second focus that I shall term dependency (and its plural dependencies). Dependency involves some form of constraint, as is seen in various dependency and co-dependency theories from World Systems Theory (Wallerstein 1976) to psychology (Rice 1998). Humans become involved in various dependencies that limit their abilities to develop, as societies or as individuals.

Imagine a table on which are arrayed some objects – an ash tray, a bottle of whisky and a glass, a crucifix. Beneath the table is a pair of high-heeled shoes. I would pass by such a table without paying much attention. These objects are of no particular interest to me. They would all merge into the background of the hall or room in which the table was placed. For me, these are just everyday objects. But for others, these individual objects might stand out as highly significant. For someone trying to recover from an alcohol addiction, all the senses would be alerted by the sight of the whisky bottle and glass. A real bodily dependency would be tested. For such a person it might be possible to think of nothing else or to see nothing else in the room except the whisky bottle and glass; they leap into the foreground. Such dependencies on alcoholic things result in billions of dollars of lost work time, of medical care and of rehabilitation programs in the USA alone.

We might say the same thing about the cigarette smoker for whom it is the ash-tray that jumps out, relating to the physical need to smoke and gain nicotine. For someone like Imelda Marcos, with a purported shoe fetish, it may be the shoes beneath the table that stand out. For a passing Catholic priest, the focus might be on the crucifix. For me, there would perhaps have to be something ancient on the table, a pile of Roman coins, that would call to my compulsion to explore the past.

In all these examples, we see various ways in which humans have physical, economic, social, psychological dependencies on things. These dependencies are associated with constraints and limits. The dependencies are not inherent in the things themselves but in the interactions between humans and things. The dependence or contingent reliance on things can become a compulsive, even addictive, dependency. In addition, there are often unequal relations of power that constrain and limit. Thus dominant groups may depend (in the sense of reliance) on subordinate groups and vice versa. But the livelihood of each group is caught in a dependency on the other (the master-slave relationship) – a dependency that is co-constrained. The various forms of dependency will be explored further as part of the discussion of entanglement in Chapter 5. I will use the words dependence or dependences to refer to the general category including both dependence and dependency, but I will also distinguish dependence and dependency where appropriate.

Reflective and Non-reflective Relationships with Things

So we have seen both that there is human dependence on things, and that dependence involves reliance, contingency and often the constraint of dependency.

Sometimes humans seem to reflect on their dependence on things, and at other times they seem hardly aware of them and take them for granted. Sometimes we reflect on things and how we relate to them; at other times, when we ride a bike for example, it is very difficult to explain in words what we have done as our bodies balance and ride the bike.

So we seem to depend on things in different ways. We have practical everyday needs for things, to eat, drink, clothe us, to comfort us, to delight us. And yet we can also reflect on these everyday needs and form abstract categories. At one level, I know what to do with things. My hand draws away from a flame instinctively. I have worked out how to ride a bike, even if I cannot explain very well how I do it. So at the sensual or practical level my feelings and behavior depend on things. It is difficult to feel pain without a flame or other source of pain. It is impossible to ride a bike without a bike. So there are interactions between my body and nervous system and objects such as a flame or bike.

At another level, maybe I can feel the pain in memory and ride the bike in my mind. So I am now thinking about my feelings and behaviors. Here again there is a dependence of humans on things – in the sense that human thought processes, connected interactions in the brain, are reflecting on other neural interactions in the body. We can think about feelings, experiences, memories.

As noted before, a thought is also a thing – a set of connected firings in the brain. So we can think about the thoughts we had about riding a bike. There seems to be a hierarchy of human-thing dependence. At more abstract levels humans think about thinking. (And in this section of the book I am thinking about thinking about thinking.) Human thinking depends on things such as prior thoughts and language and consciousness. But at another level, human thoughts are produced by thinking about experiences. Those experiences themselves may have involved feelings. But feeling too is dependent on things. It is not possible to desire without having had some experience of desiring, however much description and comparison might be engaged.

Thus in diagrammatic form, human-thing (HT) dependences are hierarchical:

(H) thinking about (T) thought

I

(H) thinking about (T) a feeling

I

(H) feeling (T) a material object/person

There are many dangers in this model of 'levels' of human-thing dependence. It assumes the different levels of human thought, perception and experience can be separated, and it does not deal with the different ways that different cultures may identify human and non-human. Nevertheless I have found the device useful in

clarifying the differences between reflective and non-reflective thought in their dependence on things.

There is a long tradition in archaeology and anthropology of separating out practical, everyday experiential knowledge from abstract reflexive thought. In 1874 General Pitt-Rivers (1906: 5) as a result of his work on military fire-arms, and on ethnographic and archaeological collections, and after experimentation with the ways in which children copied adults or made drawings of objects, wrote that 'we are conscious of an intellectual mind capable of reasoning upon unfamiliar occurrences, and of an automaton mind capable of acting intuitively in certain matters without effort of the will or consciousness. And we know that habits acquired by the exercise of conscious reason, by constant habit, become automatic, and then they no longer require the exercise of conscious reason to direct the actions, as they did at first'. Pitt-Rivers discussed the way in which a child at first struggles to learn to walk upright but over time the upright walking becomes effortless. Similarly, reading and writing take an effort of the conscious mind at first, but with practice they become automatic.

In the French traditions of archaeology, anthropology and technology studies, Mauss (1950), Leroi-Gourhan (1964–1965) and Bourdieu (1977) made similar distinctions between connaissance (discursive knowledge) and savoir faire (practical knowledge, know-how, habitus). Over the years, archaeologists have made more subtle distinctions. Thus both Wynn (1993) and Pelegrin (1990) make three-fold distinctions – in Pelegrin's case between knowledge (mental representations), ideational know-how (about sequences of production and comparisons of materials), and motor know-how (intuitive operations). In a posthumous paper, Beckaert (1998) describes a hierarchy of ways in which humans interact with and think about things. He asks when we can say that a human knows a technology such as iron smelting. Do we think that an iron smith only knows the meaning of iron smelting when the smith understands the underlying sexual structure of furnace and air nozzle, or is it only when the smith knows how to smelt? Bekaert argues for a gradual set of differences between these two extremes, rather than a simple opposition. Starting at the more practical end of the spectrum, he identifies a level of typified experience (taken for granted practical knowledge) and then moves through a series of more abstract forms of knowledge of things: the level of pragmatic motive, the level of (meta)physical intervention, the level of experiential gestalt, the level of explicit metaphor, and the level of codic oppositions (as in structuralist thought).

I will return later in this chapter to the ways in which cognitive archaeology has discussed these differences between the more reflective and more practical aspects of our relationships with things. For the moment I have simply wanted to establish that our dependence on things does itself depend – not just on the things themselves, but also on the ways in which we want to interact with them. There is a difference between the bodily motions involved in my typing away at this keyboard, and the abstract thoughts about things in general (including things such as keyboards) that I am trying to convey in this book. My typing and my motor

movements are being guided by some more abstract and general ideas and intentions – although you could of course counter that what I am saying (so far at least) is both routine and predictable!

Going Towards and Away From Things

If we take seriously this notion of a general and gradual difference but interlinking between our motor habits and abstract general ideas about things, then it seems that we can make a broad distinction between being close to things (as we deal with the oil and muck of cleaning a car or sweeping out the cattle yard) and being distant from things (as we contemplate them from a distance). I hope I have said enough already to make it clear that even when we look at things from a distance, as 'objects', we are also involved with them as 'things'. And when we look up close at the gathering work done by things we also have to deal with how things 'object'. But there is a cross-cutting distinction that I wish to explore between going towards and going away from things. Our dependence on things often seems to involve trying to escape from them as much as it involves identifying with them.

Perhaps I could open up this topic with a personal anecdote. Earlier in my career I would be invited to speak about things (abstract ideas about things) that I had come up with, certainly influenced by others, but ideas that I had a hand in developing and creating. So I would be asked to speak about contextual or postprocessual or reflexive archaeology. Nowadays I more commonly get asked to speak not about my ideas, but about Çatalhöyük, the site that I dig in Turkey. Çatalhöyük is an endlessly fascinating site and it is certainly 'bigger' than me. People want to hear about Çatalhöyük, not about me. When I give talks I struggle to find ways in which I can get a bit of me into them. I feel eclipsed, in a jealous way, by this Çatalhöyük thing. It seems so much bigger and better than me – so I wish I could get away from it, and yet I need it. So I have an ambiguous relationship with Çatalhöyük, both wanting to be closely associated with it (otherwise people would not ask me to talk) and wanting to be separate from it (in order to be me rather than Çatalhöyük).

As we will see throughout this chapter, much theory in archaeology and the social sciences argues that we need things. And we do. But we also need to be separate from things. At the most general of levels, we have a need to identify with and simultaneously be distinct from things. The movement towards and away from things was captured by Freud when he described, in his book 'Beyond the Pleasure Principle' (1920, Standard Edition 18: 1–64), the actions of his grandson Ernst as he threw objects away from himself saying 'Fort' (Gone) and then drew them back saying 'Da' (There). For example the child would throw away a wooden reel attached to a string so that he could no longer see it, and then draw it back to him. Freud's interpretations of these actions had to do with the child managing and coming to terms with the absences and returns of his mother. By repeating the

disappearance and return of the object, the child was dealing with his own pain and pleasure in relation to his mother, and later to his father when he went away to fight at the Western Front. Melanie Klein, Donald Winnicott and Jacques Lacan are amongst those who have offered their own interpretations of the child's actions in relation to an object. For my purposes here it suffices to note that the child is developing a sense of self in the dual process of rejecting and drawing close to an object.

There is a wide range of psychological literature that explores the ways in which objects are important in the development of a sense of self (Bermudez *et al.* 1995, Cole 1998, Elliott 1994, Minsky 1994, Shore 1996). The process of identification has to do with the ways in which humans move towards things; things are central to subjectification. Humans may gain control of self in the control of things around them. But the subject is also formed as humans separate and go away from things, as they externalize, transfer and displace. Human subjects as they develop identify with other people and with things; but they also want to separate from things around them and 'be their own thing'. Winnicott (1971) describes how objects help the child in the transition that involves separation from the mother. People are always already alienated from things – they are never at one with them. There is always an ambiguity – an identity and a difference.

The process of exchange provides an example of the simultaneous movement towards and away from things. At the most obvious level, one person receives and the other gives. As a thing is given away, the giver may gain a sense of self and may gain social esteem by the generosity. The person receiving may gain prestige also, both from the thing itself and from the alliances that the gift establishes. But at another level, it turns out often to be difficult to separate oneself from a thing given away. When a thing one has become associated with is given away, part of oneself may travel with it. In Melanesian gift societies, Mauss (1950) describes how giving a thing involves giving a part of oneself – so the reason that a gift has to be repaid or returned is that it contains the spirit or essence of the donor. The previous possessor of an object has a continued claim on the object (Carrier 1998). An example of all this for Mauss was the *kula* exchange in Papua New Guinea. As Annette Weiner (1992) argued, to acquire another person's valuable object such as a *taonga* is to acquire that person's rank, name, and history. In Melanesia things are inalienable – an object bears the identity of those in the past. So that as one gives, one is both separating from and remaining identified with an object.

The going towards and away from things is also at the heart of the attribution of value. The glitter of diamonds draws people to them. But in order for their high value to be maintained, the diamond market is managed so that they remain scarce. According to Simmel (1979) an object has a value that is related to the difficulty of obtaining that object rather than another one. 'As Kant has said: the possibility of experience is the possibility of objects of experience – because to have experiences means that our consciousness creates objects from sense impressions. In the same way, the possibility of desire is the possibility of objects of desire. The

object thus formed, which is characterized by its separation from the subject, who at the same time established it and seeks to overcome it by his desire, is for us a value' (Simmel 1979: 66). Gell (1992) has extended such discussions of exchange value to the value of works of art. Paintings can be objects of desire even when the sheer excessive cost of purchasing them makes possession impossible. In the case of works of art the desire to own is intellectual rather than material. For Gell, there is a magical enchanting process in the technical production of an object and it is this that draws us to the object, even while the object resists our understanding. Works of art evoke complex intentionalities to which we are drawn and even entrapped (Gell 1996).

But there is another sense in which the movement towards things is simultaneously a movement away. So far I have been talking as if humans and things were in a dyadic relationship. So a person moves towards and away from a thing. But things and persons are dispersed in a space and time so that movement of a thing or person towards another thing or person must necessarily be a movement away from a third thing or person. As I identify with one thing I reject something else and so produce cultural and social boundaries around those I identify with and those I do not. Racism, class, sexism, bigotry are the result. The 'orientation' towards familiar things involves turning away from the unfamiliar and the creation of difference. Because humans identify so thoroughly with things, they turn away from others. This takes us then, to the particular form of identity and dependence of people and things that we call property.

Identification and Ownership

Humans often want to be seen as separate from things. Humans distinguish humans from things very early on in child development (Meltzoff and Moore 1995). And things are themselves part of the world as much as humans are. So there seems something almost mystical about the ways in which humans identify with and claim to own things. Something must have been added to the thing to make it ownable, to be able to say 'this is mine'. How do identification and ownership come about, and what is the special nature of ownership and property?

It may be useful to conduct another thought experiment, taking things that seem, at first glance, very much free of ownership. So let us start with the pebbles on a beach. What is added to a pebble on a beach so that it would be possible for a human to say 'this is mine'? What is the process that leads from a freely available pebble to the notion of property? As we shall see, there are many different forms of property in different societies, but the thought experiment will help in distinguishing some of these different forms.

The process can start when, standing on a long beach, one's gaze fixes on a particular pebble. One might see a shape in it that one recognizes or likes, or one might find the colors striking. In a similar way people see shapes in clouds that are

meaningful to them. So there is a start with recognition, looking, turning attention to. This is already a form of owning and appropriating. In the terms described in Chapter 1, the object pebble has been made a thing, it has been connected to humans by the process of gazing, noticing, recognizing, comparing. It has been brought close to humans. It is the human that has been added to the pebble in order to create a form of ownership.

We might then pick up the pebble and touch it, hold it, feel it. It has now moved to a yet closer personal relationship – a holding. So now there is association, contiguity. The holding already creates a sense of a special relationship, a 'mine'. More senses are involved than just the gaze. We have become more connected to the thing through the reinforcement across different senses.

The sensory relationships with the pebble are situated within a broader set of experiences on the beach – perhaps a beautiful sunset. So the pebble becomes a thing associated with a wider set of events that may be meaningful for us. Immediately this association between the pebble and our experiences on the beach allow the pebble to be used in memory construction. And the pebble can be named as 'the pebble I picked up on that walk along the beach when I saw that great sunset'. By naming and remembering the pebble and its associations in this way, a special relationship has been created with the pebble. By naming and marking it has become more fully owned.

And because we want to remember the beautiful walk along the beach, we might then put the pebble in our pocket and take it home and put it in a box. And every now and then we might take it out and look at it and show it and tell stories and memories. It has become very much ours – in a personal way. It was something we found. And through associations and memories, and naming and keeping and conserving it has become more ours.

We might keep returning to the beach, and indeed our children and children's children may keep returning to the beach so that we argue that all the pebbles on the beach are ours through customary practice, long-term association and interest. We might thus claim usufruct rights sanctioned by historical precedent.

We might, still later, decide to buy the beach. In this case the pebbles become property from which others may be excluded. This is an ownership that can claim exclusivity, defined by societal sanction and law, and if necessary policed by the use of force. In South Africa in the 1980s access by blacks to beaches became a rallying point in the anti-apartheid movement. The going towards something involves excluding others.

These are just some of the processes by which things become first identified with and then owned by humans. As Strathern (1999) has noted, many forms of property emerge – they do not just exist as fixed. Things become possessed by us, but we also have become possessed by them, by their colour, beauty, memories, associations, etc. The processes involve paying attention to, becoming associated with, becoming linked in terms of history and memory, finding, keeping, using over time, applying force and the law to control access to things. Many of the

processes discussed in the previous section (projection, transferral, externalization, displacement) are involved in bringing us closer to things such that we may feel we need or own them. But in addition, the application of societal forces and rules creates more absolute senses of property.

There are yet other ways in which humans can identify with and claim ownership of things. One of the ways that objects become property things is through giving – through exchange and inheritance. If I take the pebble from its box and pass it to my children, then they may feel a certain right over the pebble. Thus we tend to accept that an object is owned by someone if it is exchanged, given or inherited. Of course there are many gradations here, from inalienable to alienable things, to gifts and money transfers, to keeping-while-giving (Mauss 1950, Weiner 1992, Munn 1986, Strathern 1988). In different contexts an object may be given to different degrees – the original owner may not lose all hold or rights over what is given. But at the base of this transaction is the idea that a formal giving over (as opposed to stealing for example), can transfer or even create ownership.

There are other bases for ownership of things. One version of the association argument is that laboring on a thing creates rights of ownership (as argued by Locke in the 17th century). Thus land in the United States that 'belonged' to Native Americans was grabbed by European colonizers at least partly through the idea that it had been worked – that the sweat and toil of labor in clearing, planting, weeding, harvesting created a relationship of ownership between people and land. And the same is true of much craftsmanship – there is a degree of ownership that can be claimed through the labour process, although of course in many cases this form of ownership is alienated and denied by dominant groups who provide the means of production. In all societies, Barnard and Woodburn (1988) argue that there is a principle that 'whatever I, as an individual, obtain from nature or make by myself using my own labor is residually recognized as in some sense my property' (Barnard and Woodburn 1988: 23) unless some other principle overrides this. The basic principle is that 'work … transforms material things into property' (Barnard and Woodburn 1988: 24). Of course usually these rights are overlain by others that alienate a worker from a product, but Barnard and Woodburn talk of this as a 'basic' form of property.

Overall, then, various forms of contiguity and association between people and objects lead to them being transformed into things that people can say they have an exclusive relationship with. There is a gradual shift from identification and association to ownership. I identify with many things that I do not own – my father, my name (many people are called Ian), my university, my way of dressing and so on. A property right, on the other hand, is 'a particular type of association between a person and a "thing". The type of association is one which involves a measure of socially recognized control over the "thing" and which necessitates some restrictions on other people's control of the same "thing"' (Barnard and Woodburn 1988: 13).

There are other distinctions that need to be made in relation to property. For example, property can be held both communally and individually, although often

it is not possible to separate these two sets of rights very easily (Barnard and Woodburn 1988). In addition, in my account of the pebble beach, I have imagined a society in which the move towards property ownership is taken for granted. In immediate return hunter-gatherer societies, there are low production targets, little difficulty in meeting nutritional needs, and strong social pressures for immediate use of food and artifacts so that 'not many material things are held and even fewer are accumulated over time' (Barnard and Woodburn 1988: 12; Woodburn 1998). In many societies, exclusive ownership is not sought. Carrier argues that Melanesian societies have an inclusive notion of property 'wherein an object is embedded in and reflects durable relationships between those people implicated in its pasts' (1998: 86). This differs from the modern West where property is exclusive – controlled solely by the person who owns it at any one moment. Carrier (1998) also notes that in any particular society some rights to land may be traced back to ancestors, while at the same time usufruct rights may be given to others, and then to others, so that ownership questions can be very complex, messy and contested.

So then, what is the magic, the enchantment that transforms a material entity into a thing owned? Why and how do contiguity and association allow the transfer of identity and presence from humans to objects? Mauss (1950) argued that things merge with people, they come to have personalities. Certainly it seems that humans add something to things – this added something seems to be association, recognition, common history, investment of care and labor. In all these ways material entities become things in which humans have an interest, which they then wish to protect. At the basis of property is our dependence on things such that they play a role in our lives. So we can also say that things add something to humans. The magic that transforms a material entity into a thing owned is a dual process of adding humans and things to each other.

Why is this discussion of property important? Partly because it describes the ways in which identification with things leads to the structuring and ordering of societies and of individuals in those societies. In different ways and to different degrees all societies are based on ownership of things. Dominance, power and social difference all depend on things and access to things (food, land, ritual spaces, ancestors, money). All societies involve conflictual relations of inequality that are built on things. It is in the involvement of people in production, consumption, distribution and disposal of things that society is created and sustained. If it was not for things there would be no society. It is in our joint production, ownership, exchange, transfer, keeping, disposal of things that we enter into society. It is on our obligations and duties towards each other with respect to things that societies are stretched and strained. The forms of society are intimately related to the ways in which we handle objects and transform them into something meaningful and necessary for ourselves.

Archaeologists and others in the humanities and social sciences have for long concentrated on the ways in which things, works of art, symbols of power,

technologies mean, represent. They have also focused on how things allow societies and individuals to function, how things are used so that humans can adapt to the world and to other humans. And yet there has been less focus on the processes of identification and ownership that are fundamental to processes of both representation and adaptation. I have used the artifice of a thought experiment regarding a pebble on a beach to point to the primal question of how humans become associated with things in the first place.

Approaches to the Human Dependence On Things

Having picked apart some of the strands of dependence and identified some key themes, I now wish to consider three broad perspectives regarding the human dependence on things: the phenomenology of Heidegger and Merleau-Ponty, material culture and materiality studies, and cognitive approaches. In each I want both to explore how the perspective has amassed evidence for a thorough human dependence on things and to point to a gap between the discourse on things and the things (and their connections) themselves.

Being There with Things

It is one thing to say that humans identify with things. But it is another thing to go farther and say that humans only exist in their relation to things. This idea that being human is entirely dependent on things was broached in the thought experiment about the suspended person in Chapter 1. An important contribution to our understanding of the human dependence on and mixing with things at the level of being is provided by the phenomenology of Heidegger and Merleau-Ponty, very successfully taken up in archaeology by Chris Gosden (1994), Julian Thomas (1999), Chris Tilley (1994), Karlsson (1998) and Bjørnar Olsen (2010). Some of the work of Heidegger was discussed in Chapter 1. Here I want to look more closely at the ways in which Heidegger in particular explores the thingly nature of our being.

Heidegger's aim, writing mainly in the first half of the 20th century, was to get away from the long tradition in philosophy and Western thought in which reality is some kind of substance that is approached by detached theoretical reflection (Guignon 1993). He wanted to get away from a perspective in which things were seen as separate from humans, and instead wanted to start in the very midst of practical daily activities, hammering in a nail, pouring water from a jug and so on. Influenced by Husserl's later philosophy about life-world or 'Lebenswelt', Heidegger (1973) emphasized the practical everyday-ness of human existence by using the term 'Dasein' (being there) instead of 'human subject'. He also used the hyphenated

phrase 'being-in-the-world' to point to the ways in which humans are situated in and inseparable from the world that is around them and into which they are thrown and dwell. Dasein is an ability to be which is realized through the various roles into which one is channeled in life's course. Thus my being, who I am, unfolds in the course of my interactions with the world over the course of my life.

Heidegger did not see things as somehow separate from us. Rather things are always related to us in terms of some project that we are undertaking. We become surrounded by things that all function in relation to each other and in relation to our project. All the tools, nails, wood and so on that are involved in the project of making a wooden floor constitute an 'equipmental totality'. When we pick up a hammer in order to knock in a nail, we just take it for granted. We do not need to think about the hammer theoretically when we make use of it in this routine everyday way. This type of relationship with things Heidegger called 'ready-to-hand' (parallel to the ideas of Pitt-Rivers, Leroi-Gourhan and others listed above regarding automaton, know-how, practical, non-discursive knowledge). As Olsen (2010) notes, our bodily movements and the tools are all working together to achieve a practical project – there is a unified untheorized whole in the practices of using equipment. Who I am as a person is dependent on the equipmental contexts in which I dwell.

When things break down, however, we look at them and their functional relationships more consciously and more theoretically. We turn to the thing that does not work and investigate it and we become aware of all the functions that the thing allows us to perform. How can I knock a nail in without a hammer? Heidegger called this type of conscious, reflective relationship with things 'present-at-hand'. The whole equipmental totality gets lit up and all the inter-relationships come into view.

In Heidegger's notion of being-in-the-world neither humans nor objects are the starting point – rather the starting point is the specific ways in which particular sorts of equipmental context emerge in reciprocal interdependence (Guignon 1993). Thus things and humans can only show up as they are in particular forms of historical culture. Self and the world belong together in the single entity Dasein.

Heidegger's work has been critiqued as remaining anthropocentric. We can see one example of this by considering the notion that things become present-at-hand for us when they break down. Here the focus is on the human and how the human is affected by things (whether they break down). But in the example I gave earlier of objects on a table, particular objects get lit up for particular humans not because the objects break down but because the humans would break down without them. In these cases the compulsion, addiction or dependency occur in the relationship between humans and things. Humans and things are symmetrically involved.

A further criticism is that Heidegger often takes a somewhat romantic view of an integrated being-in-the-world characteristic of rural Volk prior to modernization. His account of Dasein and the equipmental totality has everything in its

place. There is little sense of conflict and contradiction in access to goods, access to skills and materials, relations of power that alienate humans from their work. He follows the equipmental totality only so far and does not explore questions such as access to the iron that was forged into the steel hammer-head, or access to the forests and the forest livelihoods and ecosystems that may have been destroyed in obtaining the wooden boards and wooden hammer handle. Heidegger pays little attention to the outer, distant, active world of natural things that have lives of their own – to grow, mature, decay, die, disappear, run out, fall apart. His is not a materialist or environmentally determinist position; the science of matter and ecosystems are not his interest.

Yet, Heidegger's work is of importance in understanding the thorough way in which human being is always a being-in-the-world. His work seeks a full embedding of humans and things in each other. In most material culture studies the things are just stuff onto which we place or express various social meanings. But as Olsen (2010) notes, for Heidegger we are always already thrown into a particular material world that that is already meaningful. One way in which this emphasis has been successfully applied in archaeology is in studies of the response of rock art to the rock on which it is placed (Olsen, 2010). Rather than seeing the rock surface as a blank slate onto which images are drawn, the focus is on the way the art takes off from the irregularities, cracks and depressions of the rock itself, often incorporating them into the art (Tilley 1994).

Heidegger has also been summoned in recent studies of landscape, especially in Tilley's (1994) work on 'The phenomenology of landscape' which has been very influential. As Barrett and Ko (2009) have demonstrated, however, Tilley defines phenomenology as involving 'the understanding and description of things as they are experienced by a subject' (1994: 12). He argues that our own embodied experiences of landscapes and monuments today must reveal to us something of the experiences of the people who once inhabited those same places in the past. This is very un-Heideggerian. For Heidegger, the subject is always produced in and through a particular and specific historical equipmental totality. Tilley's definition of phenomenology seems to differ from Heidegger's for whom human and thing were thoroughly entwined. There could thus be no possibility of experiencing today a Neolithic response to a landscape just by looking at it and walking through it. Our responses to remains of prehistoric landscape today are situated within our own beings-in-the-world and Fleming (2006) has demonstrated the resulting subjectivity we bring to the experience of ancient landscapes. In my view a more adequately Heideggerian approach to the phenomenology of landscape would involve less walking round and perceiving that landscape through a modern lens, and more an examination of what the monuments were made of, how they were made, what equipment was used, what tools and lifting gear were used to get the stones upright and in place. It would also look at matter-of-fact issues to do with decaying bodies in the tomb, and the circulation of bone, skin and bodily fluid between them. It would reconstruct the paths between settlements and tombs, work out the labor involved,

explore the links between fields and tombs. Much archaeology over recent decades has indeed worked at reconstructing this equipmental totality (e.g. Bradley 1998).

Merleau-Ponty places a similar emphasis on the absolute dependence of humans on things. From the beginning, humans are situated in a world of things, become oriented among things and take stands in relation to them (Merleau-Ponty 1963). However, as is clear in his major work 'Phenomenology of Perception' (1962), Merleau-Ponty's main interest is how we experience the world through our bodies. Much of his writing is body-centered, but in a chapter on 'the thing and the natural world' he explores the issue outlined in Chapter 1 of the constancy of things – their existence as bounded entities that endure through time (for shifts in Merleau-Ponty's later writing see Olsen 2010: 133). A thing appears to have different sizes at different distances from the body, and it has different shapes from different perspectives. It changes color in different lights. So how do we know there is a constancy through all this variation? Merleau-Ponty answers that it is the unity of the body that gives unity to the thing. As we touch and interact with, hear, smell a thing it may change the way it looks, feels, tastes, but we know that through all this the body is constant. Each contact with a thing is held together by our own constancy (Merleau-Ponty 1962: 317). But equally 'we grasp the unity of our body only in that of the thing, and it is by taking things as our starting point that our hands, eyes and all our sense-organs appear to us as so many interchangeable instruments' (Merleau-Ponty 1962: 322). Thus in handling a thing, moving it around, feeling it, looking at it, we come to understand how our body works, how the different parts interrelate, how we can be coordinated. There is thus a two-way dependence of human bodies and things.

Material Culture and Materiality

In material culture and materiality studies there is less focus on human being, and more on how things come to have person-like qualities, how they act, have agency, personalities, spirits, powers. The emphasis remains on the constitution of self and identity, but the focus shifts to how things act in the world. The intellectual heritage for much research conducted under the headings of material culture studies (especially in the University College London school) and materiality has been described by Danny Miller (1987; 2010) as deriving from a line of scholarship reaching back to Hegel and Marx, although today there is less interest in productive relations and much more with consumption.

Hegel's (1807) 'Phenomenology of Spirit' is important in providing 'a foundation for a non-reductionist and dynamic subject-object relation' (Miller 1987: 28). For Hegel, the process of objectification involves the following stages. At first the subject is hard to describe because it is unconscious and undifferentiated (Miller 1987). The subject struggles towards an awareness that it actually is – by becoming aware that there is something it is not. Awareness of the self is achieved by creating

something which is 'other' or 'object' – this allows the self to define itself and become self-aware. So subject is defined in relation to object – something that stands against. Hegel then argues that consciousness of the external becomes dissatisfied and attempts are made to reincorporate the other into the subject, reaching a communion with self. So new transcendent and collective forces are identified such as society, law or religion or reason. These create a totalizing or universal phenomenon. This reappropriation of the external into the self is called 'sublation' (Miller 1987.). Hegel's objectification is the process by which we make the world and in so doing make ourselves (Miller 2005a). This is not a static opposition of subject and object but a flow of dialectical relations.

For Marx too, the subject creates an external world, an objectification, in relation to which the human subject develops. But his objectification is different from Hegel's in that it aims to be less intellectual and metaphysical, and to be more about relations of production in the material world. The act of producing an external world does not take place freely, but under conditions of domination – so people are estranged from, separated from, their products. So 'under conditions of estrangement, people cannot develop through objectification, because the process itself is ruptured' (Miller 1987: 36). This estrangement occurs for three reasons:

1. Separation of producer from products of labor in factory-and-market distribution systems.
2. The work place conditions create estrangement from the process of work which is seen as negative.
3. The legal and political definition of private property estranges the worker from the product.

So, for Marx, objectification comes to be seen as negative. It is in conflict with self-affirmation. I described above some of the processes by which humans come to identify with and own things. But often one form of identification with a thing (as in private property) conflicts with other forms (association through labor for example). Marx describes the processes whereby the object/product becomes distant from, moves away from the maker. In fact, in Marx and in later Marxist writing, three processes of distancing between humans and things can be distinguished; these are three negative construals of objectification.

1. *Alienation* – this is the process of estrangement discussed above. It has come to mean 'a sense of loss of authentic or proper identity' (Miller 1987: 44) in the capitalist process.
2. *Fetishism* – the worker gets separated from products and confronts them in another sphere – as commodities, which are not seen as the products of the worker's labor, but as objects to be consumed – so objects become 'false' representation.

3. *Reification* – this is where objects created by humans become so separate that they are perceived as having an external reality and an origin separate from themselves (e.g. icons ARE made). So objects have an autonomy, deflecting society's ability to be critically aware. The object 'God' is like this and so one gets to the duping role of religion.

These Marxist ideas about objectification provide a way of critiquing and analyzing the ways in which we relate to objects. They do so in terms of productive relations. In fact, in much of the work in material culture studies the focus is on consumption and on the ways that humans can transform and subvert mass-produced objects and their meanings. There is an overall withdrawal from the negative associations of objectification – they are there and important, but objectification also has important and necessary roles in the construction of the subject. 'For Miller, a theory of consumption focuses upon recovering objects from the alienated process of production, consumption is thus a strategy of self-creation in the face of alienation' (Meskell 2004: 32).

Many authors, often influenced by Gell (1998), have explored the ways in which things appear to have a sort of agency: not the primary agency of conscious human intentionality, but a secondary agency given to things by humans (Robb 2005, Dobres and Robb 2000). Spiritual and other forms of presence, almost by definition, need things to exist and flow through (Miller 2010). But it is not just the thing that creates the flow. Perhaps we are always fascinated by the being of things, however mundane and inconsequential. Perhaps we are always fascinated by the thingness of things – that is their duration in a dimension that connects us but is different from us in its own temporality. But the flows also depend on what we know about the connections of an object – they are not just based on the object itself, however beautiful and absorbing it might be in its intricacies and craftsmanship. I have often asked a classroom to handle a pottery sherd without telling them how old it was. The level of interest or wonder increases substantially, the sherd feels differently, when I tell them the sherd is Minoan and 3500 years old. So the agency and flows of things depend both on the thing itself and what we know, how we perceive and imagine the thing.

There is much recent work that explores how materials are construed in different social settings (e.g. Meskell, 2005a, b) and historical contexts (Joyce 1998, 2000, 2005, Pauketat 2001, 2007, Pels 2008). Things, matter, fluids, life, death – all these are construed differently in different historical contexts. The study of materiality explores these cultural relationships, and the biographies of objects are pursued through varying social contexts (Keane 2003a, Pels 1998). Following authors such as Georg Simmel who argued (1979: 65) that 'subject and object are born in the same act', Meskell (2004: 7) notes how in Egypt past and present 'persons exist and are constituted by their material world: subjects and objects could be said to be mutually fashioning and dependent.' As Johnson (2010: 264) notes, materiality includes 'the proposition that things create people as much as people create things'.

All this work on material culture and materiality is of utmost importance in demonstrating the thorough extent to which person and society are dependent on things. Materials and things are seen as always relational, contextually embedded within specific networks and social contexts. Materials and things are seen as actively engaged in the social process, and as going through social biographies. After all such work it can no longer be argued that self and society can be separated from things, studied independently of materials and the object world. Hegel and Marx were right. Humans and things emerge contextually in relation to each other. Since humans and things are dialectically and relationally construed, so in different contexts different types of materials, things and humans are produced. What is a human and a thing depend.

But rarely in all this do the physical, chemical, engineering dimensions of the objects come into play. Things in themselves are skirted, always embedded in meaning and discourse. This critique, made by for example Ingold (2007a, b), has been hotly contested by Miller (2007). In a study of the sari (Banerjee and Miller 2003) there is discussion of the physical attributes of the textiles used. Banerjee and Miller discuss the transparency and sheen of silk, cotton and polyester. Despite this defense of material culture studies as engaged with material things, it remains the case that Banerjee and Miller are interested in an ethnographic enquiry into how the various material attributes of the sari 'are salient for the population we encountered' (Banerjee and Miller 2003: 24). This interest in the practical meanings of things can be traced back to the dual source inspirations of material culture studies – Hegel and Marx. In his explanation of the concept of the dialectic between subject and object, Hegel refers to the real world interactions of an acid and an alkali. These are (1) initially separate and distinct, but then they (2) dissolve into each other and lose their individual properties, thus resulting in (3) a new salt with new properties (Harris 1995). But most of Hegel's account remains at the abstract level of the intellectual spirit, far removed from material properties and processes. In 'Capital' Marx uses the example of a coat to explain differences between use-value, exchange-value, and fetishism (McLellan 2000). The coat and the linen from which it is made are produced by tailoring and weaving – that is by specific forms of labour. But when the linen is evaluated as a commodity in the form of a coat, so that 1 coat is worth 10 yards of linen, labour gets transformed into abstract labour and into abstract equivalences. Use-value becomes transferred into exchange-value in capitalism, and the abstract exchange-value becomes fetishized (see above). Marx is often quoted in terms of his focus on the material conditions of life and consciousness. But he also placed great emphasis on alienation – the ways in which humans in society become distanced from things. And in 'Capital' Marx is more interested in commodity forms than in the physical nature of the thing – the coat itself (Stallybrass 1998).

Titles such as 'The Materiality of Stone', produced by Chris Tilley (2004), one of the members of the UCL school, promise something closer to material things themselves. In a discussion of Neolithic menhirs in Brittany, there is attention to

the source and grain of the rock used, and to inclusions in the rock. But the focus is on interpretation of what the inclusions look like (some look like axes embedded in the rock) and on how the differences in material suggest differences in social identities. Tilley explores aspects of the rock such as the erosion of the surfaces, and differential weathering, but interpretation is in the same terms of difference and identity. So, overall, Tilley moves very quickly from materials to social and symbolic interpretations, dualisms and transformations. It is not Tilley's aim to engage with analytical science. In Chapter 3 I will discuss approaches in archaeometry that seek to bridge this gap, but for the moment I wish to turn to cognitive archaeology and the extent to which it too has reached the conclusion that humans depend on things.

Cognition and the Extended Mind

> 'I can legitimately be held to know only in so far as objects exist to make me know. Take away, consequently, the object of knowledge (or thing known) … and you a fortiori take away from the subject: for the subject in existence is logically constituted only by the object for which and to which and by which he lives.'
>
> (Henry James 1879, xiii, in 'Society, the redeemed form of Man and the earnest of God's omnipotence in human nature: affirmed in letters to a friend' quoted by Bill Brown 2003).

A fundamental implication of the dialectical and relational view espoused in material culture and materiality studies is that there is much cultural diversity in the ways in which humans construe things. Cognitive approaches across the human sciences often have a propensity to assume some degree of universality in the ways in which the mind works. We might, then, expect a very different type of understanding of the human dependence on things to emerge. While some of the influences on cognitive archaeology derive from anthropology (e.g. Appadurai's (1986) 'The Social Life of Things') and pragmatic philosophy (Searle 2000, see also Preucel 2006), other influences derive from cognitive studies and neuroscience, evolutionary psychology, computational efforts to reproduce mind, and even from robotics (Donald 1991, Clark 1997).

In outlining a cognitive archaeology, Renfrew (2001, 2004) takes a similar stance to the other scholars described in this chapter in that he seeks to get away from the notion that either the material or the ideal must have primacy. He outlines a concept of 'engagement' which partly deals with the mixing of things and people, partly argues that things have social roles and social histories, but also insists that things often come before concepts. There is a unifying of mind and matter (Renfrew 2004: 23) such that 'the symbol cannot exist without the substance, and the material reality of the substance precedes the symbolic role' (2004: 25). The material world is constitutive of social facts. Thus notions of

measure and value depend on things (that can be weighed and compared with each other).

Thus much of this work contrasts internalist with interactionist views of cognition (Jordan 2009). According to the internalist view, cognition is an internal, centralized decision-making function that uses perceptual input in order to generate behavioral output. According to this view, the archaeological record and all material culture are the products or results of cognition. As onlookers or archaeologists we can then interpret or read cognitive meanings by seeing what people do with things – we can interpret what things represent. But according to a radical interactionist view, cognition is 'spread out' across brain, body and world. The external world provides constituents of cognition, and material culture and the archaeological record are involved in a distributed cognition. This latter perspective has many convergences with Heidegger's notions of Dasein and being-in-the-world, and indeed Andy Clark's (1997) book on cognitive models is entitled 'Being There'. There are also convergences with materiality studies in which things and humans are contextually and dialectically related and with phenomenological accounts of humans engaging with landscapes. Clark (1997) worries, however, that this new broad consensus on getting rid of the central computational and logical schemas in cognition may go too far. He argues against the idea of representation as action neutral – but he does see that brains do represent aspects of a real independent world. 'The recent skepticism concerning the role of computations and representation in cognitive sciences is, I believe, overblown' (Clark 1997: 174).

Bearing this in mind, there seems to be widespread agreement, from Merleau-Ponty to Renfrew and Clark, that humans think through material culture. The sentiment expressed in the quote from Henry James above is taken seriously and captured, for example, in the title of a book by Carl Knappett (2005) entitled 'Thinking through Material Culture'. Cole (1996: 136) describes the Russian culture-historical school of cultural psychology (e.g. Vygotsky) in which 'what we call mind works through artifacts' (see also Shore 1996: 34 and Geertz 1973: 76). One example of this human dependence on things is seen in the workings of memory, which often seems to depend on external storage systems such as writing or material culture (Donald 1991, Knappett and Malafouris 2008, Renfrew 2004). According to Merlin Donald, technologies and media have constituted part of human cognitive architecture since the Upper Palaeolithic. Changes in external symbol systems have altered the capacity for human memory.

It can further be argued that much cognitive action depends on external stimuli. 'We may often solve problems by "piggy-backing" on reliable environmental properties. This exploitation of external structure is what I mean by the term *scaffolding*' (Clark 1997: 45). Clark (1997: 61) gives the example of being asked to multiply 7222 x 9422. Most of us resort to pen and paper or a calculator. By using the pen and paper we reduce a complex problem to a series of simpler problems beginning with 2 x 2. So the external environment becomes a key extension to our mind. Even if we do the sum in our heads it may well be

that we manipulate a mental model in the same way that we manipulated the real world model.

We often arrange the external world to help us in our cognitive actions. For example, in repairing an alternator we may take it apart but place the pieces in a linear or grouped array so that reassembly is easier; or in doing a jigsaw we may group all those with a straight edge together, or all those with the same color; or playing Scrabble we physically order and re-order the tiles in order to prompt our own neural resources. The fact that we find this useful suggests that our in-the-head computational resources do not work so well on their own – they need the external prompts. So our thinking comes about as an interaction between brain and world (Clark 1997: 65). 'Human reasoners are truly *distributed* cognitive engines' (Clark 1997: 68).

Thus, studies in neuroscience and robotics suggest that humans work things out in an embodied practical way. Despite Clark's comments above about going too far in retreating from the idea of centralized computational reasoning, much human practical life is less careful planning and more situational problem solving. This view parallels that of John Barrett who has argued that Neolithic monuments are not just the results of abstract plans – but of on-the-ground situated activity (Barrett 1994). The idea of working with materials in order to co-produce things has been explored by Ingold (2000) in his accounts of making a basket or building a cathedral. Boivin (2008) provides further persuasive examples. In her ethnoarchaeological work in southern India the use of soil in plastering houses was not just symbolic, but was practical and embodied.

In such examples we could go farther than saying that cognition is distributed and argue that self extends into the material world around. Indeed, there is considerable cultural variation regarding where boundaries around self and other are drawn. As Strathern (1988) has shown, ethnographic evidence demonstrates that the self and personhood may be continuous with objects in the world, and this insight has been applied in archaeology (Fowler 2004, Knappett 2005). Malafouris (2009: 91) suggests that in the Homeric epics there is 'an absence of awareness of a unitary self and thus no Homeric person can be seen to act as a fully integrated and autonomous agent'. Thus Homer describes a sense of self that is different from our own and that is thoroughly distributed. Even in the contemporary Western world, however, the self often seems continuous with the world around it. Merleau-Ponty discussed the blind man holding a white stick with which he found his way around. In such a context, where does the blind man's self begin – at his hand or at the end of the stick? (Malafouris 2009).

Thus current cognitive research strengthens the claim that humans are thoroughly dependent on things, and indeed allows return to my thought experiment about the suspended human in Chapter 1. The human is only possible if it has things to think through. Other work in cognitive archaeology explores the ways in which human-thing dependence varies through time. I have already mentioned the scheme of Merlin Donald (1991) in which an early mimetic

culture is followed by mythic cultures and then those based on external symbolic storage such as writing. This scheme has been emended by Renfrew (2001). Osvath and Gärdenfors (2005) argue that Oldowan stone tool manufacture, transport of stone tools and food over long distances and the use of accumulation spots created a niche that selected for anticipatory cognition, the ability to mentally represent future needs and planning for future goals. It is difficult to amass evidence for such claims, but Stout *et al.* (2009) have been successful in developing experimental tests about hypotheses regarding early cognition. They wished to explore the link between tool-making and language. They undertook PET (Positron Emission Tomography) scans of people during experimental toolmaking. The imaging data showed that the neural circuits supporting stone tool-making partially overlapped with language circuits. This link was then claimed as support for a co-evolutionary development of language and tool-making. Such conclusions remain difficult since in this case the tool-makers were professional archaeologists who would have had a language-based understanding of the tool-making process – it thus seems hardly surprising that for such people language and tool-making neural circuits were linked. Nevertheless, such PET studies have great potential in allowing exploration of the links between cognitive processes and practical interactions with things.

In *The Descent of Man*, Darwin (1883, 50) described how the structure of the hand had evolved because of the use of tools. A post-Pleistocene example of gene-culture co-evolution is the spread of lactose tolerance linked to the spread of domestic cattle and milk (Richerson and Boyd 2005: 193). In such examples (and for numerous others see Boivin, 2008) the human physical body is as it is because of its interaction with things. And the same can be said of human cognition. Terrence Deacon (1997) has made a persuasive case that the development of symbolic communication, especially language, produced a context in which a large increase in the prefrontal cortical parts of the brain was selected for. Richard Byrne (1997) argues that in some instances in human evolution social complexity affected brain evolution, but in other cases it was technology. Fruth and Hohmann (1996) suggest that ape nest making and tool use selected for new cognitive skills (Boivin 2008).

Overall, then cognitive approaches in archaeology have run in parallel with studies deriving from philosophy, anthropology and the social sciences. There is a tendency towards looking for universal relationships and evolutionary schemes, but the direction of such claims has been towards a re-statement of the necessary linkages between mind, body and thing. There is an overall acceptance of the general view that cognition is worked out in the practices of engaged daily experience with things. Although there remains a danger in withdrawing too far from the abstract cognitive abilities that define human thought processes, it seems that many of even the most abstract thought processes are based in real-world interactions. I have several times in this book used 'thought experiments' to get over an abstract thought. It seems we do this much of the time.

It ought to be the case, then, that the specific material character of things enters into our thought processes and contributes to our cognition. While this may be agreed at an abstract level, most studies in cognitive archaeology remain shy of getting to grips with the grain of things themselves. An anthropocentrism lurks, as researchers turn to PET scans of the brain, to language, to notions of distributed selves, distributed memory and distributed cognition. In all this it is the human that is the focus of attention. We 'piggy-back' on things or we are 'prompted' by them. The 'engagement' remains fairly superficial because the things themselves act as props rather than as co-producers. We remain focused on mind and on what things bring to mind rather than on the intricacies of materials and their engagements with us.

Conclusion: Things R Us

All the approaches, old and new, discussed in this chapter have converged on the view that humans are so thoroughly dependent on things that it is difficult to imagine humans even existing without them (Webmoor and Witmore 2008). As in the thought experiment in Chapter 1, humans need sensory input in order to feel, touch, see, smell, hear, think. We would not have evolved as we are, with agile fingers and complex brains were it not for the niches that made things provided for us.

So human existence is thingly, irreducibly so. Things flow through us. The nutrients from food flow through our body and are excreted. The warmth from the fire heated in a blanket flows through and revives our senses. The light from the sun streams into our eyes and awakes our vision. The smells and sounds from animals alert our fear and protective impulses. We hold and handle objects and become aware of perspective. Spiritual energies flow through icons and relics and awaken our devotion. Familiar things are absorbed into our sense of identity; they become recognized and owned. Things provide a psychological comfort after tragedy and loss. Things stimulate our cognitive capacities, flowing through our neural processes, leading to reflection upon reflection, creating pathways that stay with us. There is a dependence of humans on things.

We move towards things and take them in. But also we object. We move away from dangerous things, we only eat certain foods. We take up defences and build walls. Owning things is always at the expense of others, and so there is distancing and alienation. At the personal level we form identities by rejecting things, refusing to do things in certain ways, denying certain ways of seeing, feeling, acting, doing things. Some of us search for identity and spirituality in the ascetic denial of things. Ritual leaders and philosophers deal in abstractions – thinking about thinking about thinking, turning away from things, examining things as objects. But even our turning away depends on the things we have denied.

The work described in this chapter has been successful in demonstrating the ways in which human existence involves the movements towards things and away from things. If human being is thoroughly dependent on things then it might have been proposed that the separate material grain of objects contributed to the shape of being. But in most of the work in the social and human sciences in which humans and things co-constitute each other, or fluidly mix together, there is, oddly, little account of the material object nature of things themselves. Most anthropological and archaeological accounts of materiality or material agency or material cognition remain human-centered. Most of these accounts seem shy of using a traditional archaeological methodology. When archaeological practitioners look at things, they measure and draw them, analyze chemically the constituents, describe and source their parts, quantify changes through time and across space. They take the thing very seriously and describe it very fully and use analytical techniques derived from the natural sciences. Despite attempts made by, for example, Andrew Jones (2004) and others to link archaeometry to current social theory, there is very little detailed description of artifacts in much of the literature dealing with materiality, material agency, phenomenology and cognition. It is the aim of the rest of this book to move beyond the types of approaches described in this chapter and to explore the object nature of things and their connections.

Chapter 3
Things Depend on Other Things

My image starting this chapter is of that feeling of frustration when, close to finishing the assembly of an IKEA piece of furniture such as a table, I realize that there are not enough of those small metal screw gadgets and the table will not stand up without that one piece that connects the leg to the table top.

There has been a conceit to what I have written so far. We humans live our lives dependent on things. As human and social scientists we have become increasingly aware of this fact. As social theorists we have made things more and more in our image, as having agency, as transferring power and meaning. As social scientists we have even subverted the word 'materiality' to refer not to materials themselves but to the ways in which people construe materials. We have alienated things from themselves. We have 'returned to things' in order to dominate and appropriate them. We have created our own empire with its ranks of enslaved things that we jealously guard from the natural sciences. As social theorists and social archaeologists we have tended to absorb things and the sciences of things (chemistry, physics, biology, geology, engineering, materials science) into our socially constructed worlds.

Archaeology, however, finds it difficult to dwell solely in the realm of the social sciences and humanities. It is undeniably the case that archaeologists are dependent on chemistry to discern the food residues in pottery, on biology to trace ancient DNA, on geology to fathom the sources of materials, on engineering to understand how monuments were constructed, and on physics to date carbon. Archaeology sits astride the divides between the humanities and social sciences and the natural sciences. And yet there has been little successful integration of knowledge about the natural world of things with the types of social theory discussed in

Entangled: An Archaeology of the Relationships between Humans and Things, First Edition. Ian Hodder.
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Chapter 2. There we saw over and again that little attention is paid to the physicality and chemistry of things. The aim of the rest of this book is to try and develop an approach that takes things seriously and breaks away from the fragmentation of archaeological and material culture theory. Is it possible to develop a theory that gives real symmetry to humans and things (as argued by Latour 2005 and Behavioral Archaeology – see below)?

In seeking a more symmetrical view in which the object matter of things is taken more seriously, there is a temptation and a tendency to lurch back into a materialism or naturalism that is determinative of human behavior. It is not my aim to reject all the rich contextual specifity of human-thing interactions described in Chapter 2 in order to reduce society to behavior determined by material and biological causes. I wish to avoid reductionism, retaining all the gains that have been made in understanding human dependence on things. And yet I wish to incorporate adequate accounts of the objectivity of things – the fact that they stand up against us. Bridging the divide between human-centeredness and thing-centeredness is the aim of the rest of this book.

In searching for symmetry I wish to move towards a discussion of how things depend on humans in Chapter 4, again exploring both dependence and dependency as described in Chapter 2. But in order to reach an adequate discussion of thing dependence on humans and of entanglement in Chapter 5, I wish to start with a consideration of how things depend on other things. We are used to discussions of how humans depend on other humans, but we are perhaps less used to think about thing-thing dependence. We need to understand how things depend on each other before we can explore how they depend on us.

So in this chapter I will return to some of the themes outlined in Chapter 1 – that things are not isolated, and that they are not inert. Things are connected to and flow into other things, always transforming and being transformed. But my aim, as already noted, is not to lurch back across the divide into a human-less materialism and objectivism. Humans will not be absent from this chapter. For humans, links between things occur in Heidegger's 'equipmental totality' (see Chapter 2), so in our everyday dealing with the world there is a web of functional relationships in which things are encountered in their interdependent functions and in terms of their relevance to what we are doing (Guignon 1993: 10). The world of practical activity includes the network of internal relations (references) among the tools, and their external relations (assignments) to the purposes of the humans who use them (Hall 1993). Thus things show up or matter or count in terms of how they are fitting in our future-directedness – our human projects. Given that I am cooking in the kitchen what matters are the spatula and the pan rather than the linoleum and the wainscoting which recede into insignificance and we saw in Chapter 2 that things are brought into different relationships with other things in human projects. So my aim in this chapter is not to purge humans from thing-thing interactions, but to explore how things connect with humans in those interactions.

Of course, there are 'natural' dependences between things in physical, geological, chemical systems and in ecosystems. Things are held on to the earth by gravity, acid and alkali interact, the river flows through banks of different materials, carnivores consume herbivores that consume plants. Since the spread of modern humans, many ecosystems have been affected by human presence and many 'natural' dependences are influenced by human-induced hunting, burning of the landscape or intensive gathering and fishing (Roberts 1998). So, rather than separating natural and cultural thing interactions, I will simply explore the processes by which things depend on other things.

Forms of Connection between Things

Perhaps one consequence of the human-centered approaches I described in Chapter 2 is that things have appeared to us rather directly as separate, bounded entities. But as noted in Chapter 1 my usage of the word 'thing' draws attention to the Old English and Old High German origins of the word meaning assembly (Webster Dictionary). A 'ting' was a drawing together (Heidegger 1971, Olsen 2003, 2010). In fact, archaeologists have excavated early Scandinavian 'thing' assemblies (Sanmark 2009). These Viking-Medieval sites in Sweden had a very specific role in relation to the rise of the state. Late Viking 'things' were mainly created in the 11th century, were Christian sites, and were established by local elites as part of the establishment of unified centralized power. They were the public assemblies of free men and they acted as both parliaments and courts. They played a role in conflict resolution, marriage alliances, power display, honor and inheritance settlements (Sanmark 2009: 205). 'Things' often included or were close to earlier burial mounds and they often contained rune stones. They occurred at road and river crossings. Thus these early 'things' were very much involved in making connections between people and places, and with making connections to the past, linking everyday life with politics and the divine. The 'things' drew people, places, times together within a very specific sociopolitical context of increasing centralized power.

So we already see in these Viking 'things' different types of connection – transport, marriage, religion, politics. But there are also the physical connections made with the landscape as stones are brought to stand at the site and are inscribed with runes. More generally, it is possible to outline various types of connection (described by Schiffer as interactions – see below) between things.

Production and Reproduction

Things are linked to each other in reproduction (of humans, animals, plants) as fields are prepared for crops, animals are protected and humans are birthed.

Processes of production link together all the tools and materials in procurement and manufacture, all the locales and knowledge involved in obtaining raw materials and transforming them into products for human use. In making iron this assembly includes furnace, fuel, fire, bellows, ore, tongs, hammer, cooling water, and so on.

Exchange

Links are made between things as gifts are given and received. These links can often be quantified (as in Marx's discussion referred to in Chapter 2 of the value of linen in relation to a coat) and the early development of equivalences of value in exchange has been argued by Renfrew (2001). In addition, things given often remain associated with histories and memories; including what they were exchanged for (Weiner 1992). Even if substantial delays occur between a gift and its return, exchange creates links between things.

Use

As things are used, consumed, applied, they are brought in relation to other things. The steel hammer head needs a wooden handle if it is to be used, and the handle will only stay attached to the steel hammer head if a metal or wooden wedge is used. Then there are the nails, the wooden planks to be nailed, the cross beams to which the planks are nailed and so on. In ecosystems different parts of living systems work in relation to each other. In engineering the different parts of the bridge have loads that are calculated in relation to other parts in order for the bridge to stand.

Consumption

A particular form of use, the consumption of things by social actors, always works by reference to other things as humans copy, ape and imitate. Mimesis always occurs in relation to a cultural and social field from which examples are derived and emulated or rejected. Consumption takes place in locales and at moments in which other things are also brought into play, the different dishes involved in a meal, the different components of a feast or competitive display.

Discard

Things get associated with each other as they move through common life-histories, at times leading to joint discard – all the parts of a meal, or all the sweepings from around a hearth, or all the contents of a room or house discarded together. Things are mixed in middens and land-fills.

Post-deposition

Things may be further mixed together as flesh rots, buildings decay, roofs collapse, and as deposits are washed down slopes.

In each of these types of connection there are heterogeneous assemblages of things – objects such as tools and furnaces, but also institutions (the guild of metalworkers), places, humans, social groups, rules, metaphors, rituals and abstractions. The parts of these heterogeneous assemblages are held together by flows of energy, matter and information. Thus energy is transferred from plants to animals to humans in food consumption; energy moves from the fire through the pot to the contents of the pot and then into the human eating the food; matter moves from source to production site and is exchanged, used and deposited; information flows through emulation and mimicry and through kin and family networks.

But also flowing through these heterogeneous assemblies are all the human dependences discussed in Chapter 2. The things in the networks are the foci of debts, obligations, rights. Since humans are involved in these networks, processes of identification and ownership become activated. The things assembled also assemble human alliances, subjects, duties, attachments. The things become entwined in the human to-ing and fro-ing in relation to things. Thing-thing relationships are never just about things; they are also about obligations and dependences. The smelting of iron is not just about hammers and tongs. It is also about debts, rights, duties, identities, sexual metaphors and relationships with the divine. As work on social technologies (Lemonnier 1993b), exchange (Weiner 1992) and material culture more generally (Miller 2005b) has shown, doing things with things is always embedded in human sociality.

Even the earliest cultural acts, such as the making of fire (Figure 3.1) involved an assemblage of objects from fire-making tools, to the pit in which the fire was made, to the wood used for fuel, and thus the containers or tools used to cut or collect wood, and so on. It involved social units that participated in receiving warmth, protection and cooked food from the fire. The energy from the fire coalesced humans around things in the projects of keeping warm, gaining energy, getting light, cooking food, forming social alliances and so on. Keeping the fire going must itself have involved duties and obligations.

The winning of clay at Çatalhöyük depended on tools to dig the earth with (Figure 3.2. See Hodder, 2006 and box on page 60). The placing of clay plaster on walls involved cattle scapulae that were used to spread on the clay and river pebbles that were used to burnish the surface. Use of plaster involved digging clay pits in the KOPAL area near the site, containers (e.g. baskets) to carry the marl clays to the site, and the plaster interacted with the brick walls on which the plaster was placed, holding onto the mudbrick. This particular type of plaster allowed animal horns and skulls to be plastered over to make plaster reliefs on the walls. The plasters absorbed paint well and were easy to paint on. Used on the floors, the plasters assembled dead and living humans also, since the plasters interacted with

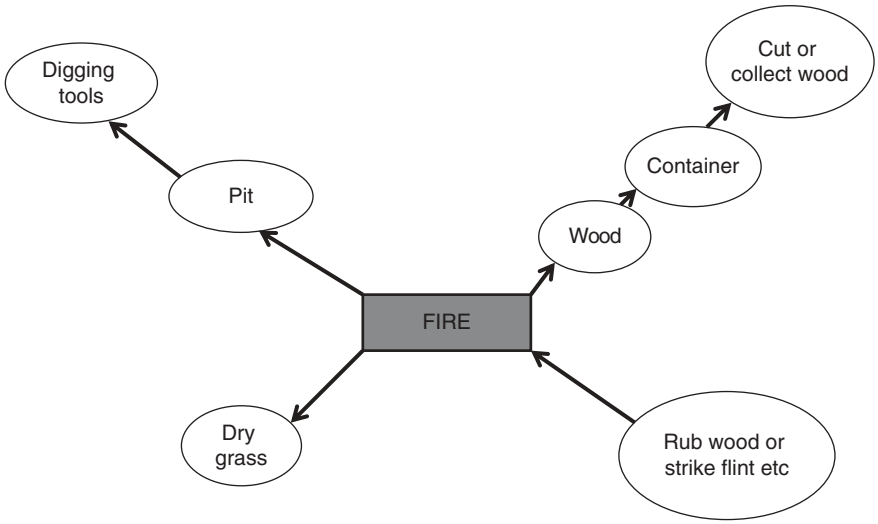

Figure 3.1 Some of the tools and processes involved in making a simple fire (Source: the author).

decaying human bodies beneath the floors and absorbed odor. They made the house livable and hygienic, reflecting light and providing smooth surfaces. Plastering house walls involved institutions (the social group living in the house), production, exchange, discard. It allowed the transfer of energy as light was reflected by the white plaster surfaces around the room and as the fluids of bodily decay were absorbed and chemically transformed. The social was thoroughly embedded with the material since the social functions of burial and inhabitation depended on physical-chemical interactions: the humidity in the house determined whether the plaster could effectively absorb odor and maintain hygiene. In addition the plastering involved rights of access to clay sources, obligations (to keep replastering in order to keep the walls white) and social duties (some houses have up to 450 layers of fine plaster, perhaps renewed on a monthly basis).

The early use of the wheel involved a still greater network of connections and interactions (Figure 3.3). The wheeled cart emerged in the 4th millennium BC in Europe and the Middle East at more or less the same time (Bakker *et al.* 1999). The wheel, initially a wooden solid, was used in two and four wheeled carts, often pulled by oxen. It may have been used in warfare, but also in transport, and had a symbolic significance in burials (Piggott 1983). The early use of the wheel was embedded within a particular network that involved transport of goods, burial ritual, bog deposition. There was a close link to what Andrew Sherratt (1981) termed the Secondary Products Revolution – that is the more intensive use of domesticated animals for secondary products such as wool, milk and as draught animals, themselves linked to the emergence of the plough. There is also a temporal link to the emergence of the potter's wheel. So there was a whole assemblage of things and energies surrounding

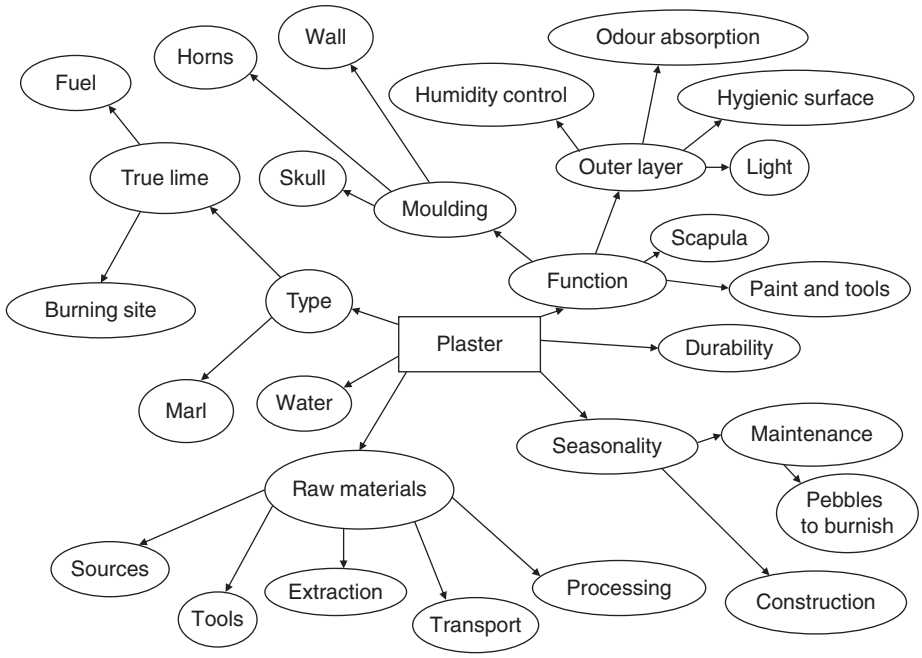

Figure 3.2 Some of the tools and processes involved with plaster at the 9000 year old site of Çatalhöyük in central Turkey (Source: the author and Chris Doherty).

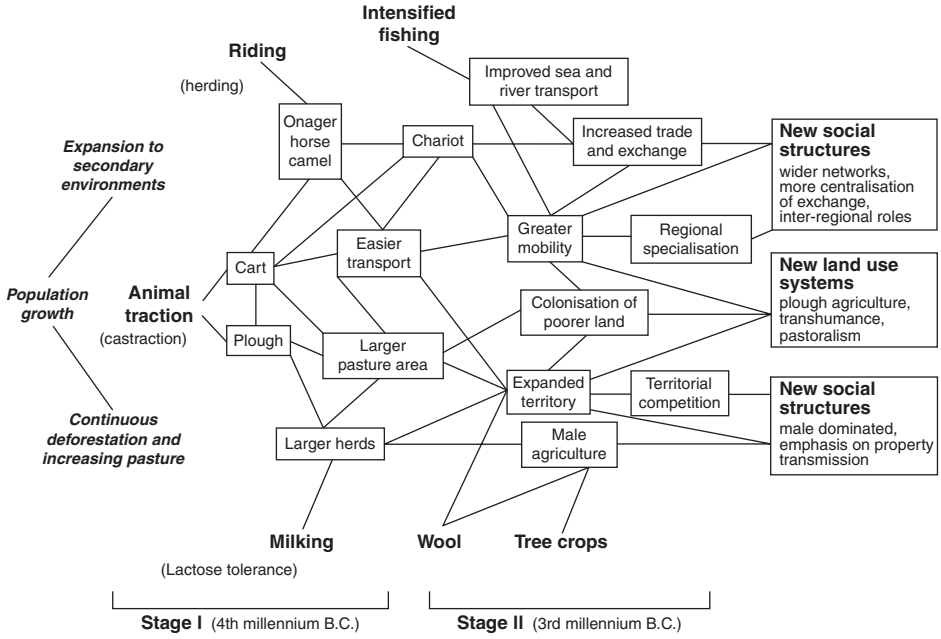

Figure 3.3 The introduction of the wheel in European prehistory (Source: Sherratt 1981).

Figure 3.4 The parts of a modern car (Source: http://www.rpmgo.com/tag/car-parts).

draught animals, pots, ploughs that emerged at the same time and made the wheel possible. But by the time and place of the 3rd and 2nd millennia in Anatolia and the Middle East, as well as China and Egypt, the wheel had also come to be embedded in a different network. As a spoked wheel it gradually became part of a fast horse-driven chariot, central to warfare, heroism and manly prestige. But the edges of these wheels tended to wear out against hard surfaces. So for the wheel to continue it had to be provided with a protective covering such as leather, and later a metal rim or hoop. So the wooden wheel came to depend on other things – on metal rims for example – for it to continue in existence. But it also depended on new technologies, new flows of energy, new social strategies and conceptual schemes.

But each of these interactions or connections between things is miniscule in relation to the 10–20 000 parts needed for the modern car (Figure 3.4), obtained from all parts of the globe and involving trade agreements, tax systems, bureaucratic procedures and transport systems. Here the wheel has become associated with global politics (in pursuit of oil resources), new technologies, and whole ways of life dependent on car transport.

Any thing is dependent on the other things used to make it, to use it, to repair it, to discard it. It bears the marks of these other things and archaeologists have long been adept at the study of the traces on things to see how they were used and made. I have drawn attention to the complexity and heterogeneous nature of these

equipmental networks. And yet Figures 3.1 to 3.3 instead of 4 remain over-simplified. Social actors may have some knowledge of these schemas (though see below) but they remain schemas. In practice things are much more complex. We can take the simplest example – the making of a fire. In Figure 3.1 everything seems under control in a closed system. But in any particular case the wood may be too wet to light, the wind may have changed direction, or one's hands may be too cold. Never mind all the social issues – whether one can still obtain a fire-making stick from a friend. So the diagram cannot encapsulate ALL that is going on. The system is open and other variables come into play all the time. In practice, one has to work it out – to cobble something together – to be creative in making use of or extending the network in the moment.

There are four key points, some already familiar, that I wish to draw out from these examples. First, the connections are very heterogeneous such that human and thing, subject and object, culture and nature are all thoroughly intermingled. Things are not isolated. Rather they are nodes for the flows of inter-linked bundles of matter, energy and information. Second, the threads or chains in the networks are very extensive and far-flung. Thingness, like personhood, is very distributed. Partly as a result, third, many of the connections of things are invisible to the social actor and there are many unacknowledged conditions as will be discussed in Chapter 5. A person exchanging obsidian at point A may have little idea of how the material was mined at the source, where the source was, or how it got from A to B, despite the fact that histories, fame and debts do often flow with objects exchanged (Weiner 1992). In the contemporary world we often do not know where something was made, what is in it, whether sweat-shop labor was used, how much people were paid. There is often a forgetness to things, especially when things descend into the background, unthinkingly ready-to-hand rather than consciously present-at-hand. Fourth, there is much uncertainty since the system is entirely open. It is impossible to draw a picture of a network or assembly as there are always uncertainties about how things will work out. The assemblies shimmer and transform as they are put into practice. It always depends. I will return to this point in a discussion of the transformation of networks in Chapter 8.

Affordances

Archaeologists recognize that the relationships between things are very much constrained by or influenced by the materials and the things themselves. Thus the forms of things at least partly derive from the materials. As Pitt-Rivers (1875: 34–5) put it in relation to flint axes, 'a long thin nodule produced a long thin celt, a broad thick nodule a broad thick celt, and so forth. Indeed, so completely does the fabricator appear to have been controlled by the necessities of his art, that in tracing

these successive forms one is almost tempted to ask whether the principle of causation lay mostly in the flint or in the flint-worker'.

The notion that the properties of materials or things afford certain outcomes has been championed by archaeologists (e.g. Knappett 2005) influenced by the work of James Gibson (1986). Gibson defined an object as 'a persisting substance with a closed or nearly closed surface' (Gibson 1986: 39) and he identified different types of object such as detached, attached, hollow, partial (Gibson 1986: 34). He defined the affordances of an object as its potentialities for a particular set of actions. 'The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill' (Gibson 1986: 127). An environmental medium (such as air) affords respiration, permits locomotion, can be filled with illumination. Fire affords warmth and illumination, as well as the cooking of food and the boiling of water, it affords the glazing of clay and the smelting of metals. But fire also affords injury to the skin in burns (Gibson 1986: 36–38). Gibson (1986: 40) talks of man-made objects or tools in the same way – so a pointed object affords piercing (a spear, an arrow, an awl or a needle).

Thus one might be able directly to perceive that an object has the potential for sitting on without or before it is categorized as a 'chair'. In fact, all things are embedded in particular forms of knowledge. As Knappett (2005: 45) points out some mailboxes look like trash bins and so some cultural knowledge is needed to know how they can be used. Gibson argues that the affordances of the environment are both real and objective, and yet they are also psychical. 'An affordance points both ways, to the environment and to the observer' (1986: 129). Gibson's notion of affordance transcends the subject/object split. Knappett's own analysis of a coffee cup tries to focus on the cup's physical affordances, pretending the absence of cultural knowledge. The cup has a flat base and a low center of gravity – from this he deduces the affordance that the cup can sit on a table. The cup has a hard and brittle fabric – so it has the affordance of being used with hot liquids. The cup is not too heavy and it has a handle – so it has the affordance of being raised to the mouth. It is of a size to be held by one person in one hand. So in a context in which someone wants to consume a hot drink, and could choose between variable objects, the coffee cup 'would presumably announce "directly" to the user its appropriateness to the task at hand' (2005: 112).

This notion that the flat bottom of a pot entails a table is extremely important. The table top may also be flat and horizontal so that it can hold vessels. So things are connected by the fact that they work together. Handles of pots fit our hands, or lugs on pots afford the potential to tie a string so the pot can hang from a beam, or spouts on jugs allow liquids to be poured into cups, or pots have lips that fit our lips. In all these ways the material world is connected to our bodies, to other things, to society, to the other parts in the complex networks. Materials afford certain potentials: thus plastic allows new shapes, reinforced concrete allows larger buildings, the Eiffel Tower would not have been possible in wood. There is a generality to these potentials, though always instantiated in particular networks

in particular ways. When Knappett extends this type of analysis to the affordances of a Proto-Palatial Middle Minoan drinking cup from Crete, the limits of a universalizing approach to affordances are clear. The Minoan cup has a low center of gravity and is made of well-fired clay, but without the impermeability one might expect for hot liquids. There is a vertical handle and a size that would suit one person. So in a context in which drinking was the activity, 'the Minoan cup would announce itself as a suitable object for such ends' (2005: 142). While archaeologists are often forced into making such decontextualized claims as starting points of analysis, there are clearly dangers and in practice there is often a need for supporting evidence – such as residue evidence for the use of liquids, or representations of the cups being used for drinking in contemporary art. In this way it is possible to reconstruct the particular forms of knowledge in which an object is embedded.

Archaeologists aim to learn as much as possible of the physical and chemical properties and potentials of things (Pollard *et al.* 2007, Tite 1972). There are always dangers in assuming that a particular object was used in particular ways just from its form and material, and there are normally other strands of evidence such as use wear, residues, breakage patterns, context of recovery, that can help interpretations of use. It is important to engage in as much experimental work as is possible in order to examine how a particular thing could have been used, based on its physical and mechanical properties (Coles 1979, Mathieu 2002). But these properties always have to be situated within a particular network to see how the thing might connect with other specific things. Gibson describes mutual affordances. 'In architecture a niche is a place that is suitable for a piece of statuary, a place into which the object fits' (Gibson 1986: 129). In ecology a niche is a set of environmental features that are suitable for an animal. 'The niche implies a kind of animal, and the animal implies a kind of niche' (Gibson 1986: 128).

The study of affordances is thus a component of the study of the mutual connections between things based on their material form and material potential. Ingold (2000), in an account of weaving a basket, describes how the form-generating process involves a subtle interplay between the material being weaved and the intentions of the weaver. Similarly, Malafouris (2008) describes how the potter, in the first minutes of action at the wheel tries to center the lump of clay on the wheel. The potter has a schema as she works but she is unable simply to impose a pre-designed plan. What happens in those first moments as she works is an interaction between her fingers and the clay and the forces of the wheel. She uses a particular grip to draw the clay up into a pot shape. A large part of this process is the potter responding to the wetness and nature of the clay – the texture of the clay and its physical properties. The hand movements involve squeezing, supporting and controlling and turning as the potter interacts with the potentials offered by the clay, its moisture, the wheel, her hands and her mind, skill and cultural knowledge. The end-result is a mutual affordance between all these and many other factors in the network as a whole.

From Affordance to Dependence

I have so far in this chapter been talking of the connections between things in networks. Later in the book I will abandon the notion of networks in favor of entanglements (see Chapter 5), and the main reason for doing so will be that networks are riddled with dependence and dependency as will be discussed further in Chapter 4. But even in thing-thing relationships there is often an inequality. Rather than a mutualism of affordances and dependence there is often a limiting and constraining dependency. The potentials of materials can have a negative feedback on other variables. So the potential of deeper ploughing in agricultural fields is to increase production as more nutrients are drawn to the surface and made available for plant growth. But deeper ploughing over the longer term can end up depleting nutrients in the soil (as organic soils are eroded off fields and slopes) and decreasing production.

Whole assemblies of things may be dependent on and constrained by one small key thing. An ocean-going sail boat is a very well designed thing. It has to be to function efficiently in life-threatening and sudden situations. Everything on a 26 foot Columbia boat is well designed to work together to allow the function of sailing. Everything is tightly crammed, beautifully stowed, neatly fitting into available spaces. All the stays, halyards, sheets, ropes, sails, cleats and knots have been carefully thought through and they all work together wonderfully on a smooth day's sailing. But it is interesting to note that all the thousands of component parts on the boat depend on one small 1 inch long piece of metal. This small piece, round in cross-section, expanded at one end and with a screw thread at the other holds the sailing boat together. This small metal piece fits into a shackle that links the top of the mainsail to the halyard (rope) used to pull up and keep up the mainsail. Without this small threaded pin, the shackle could not be closed and the halyard would not hold up the mainsail and it would be impossible for the boat to sail or for any of the other sailing parts of the boat to work. I will return in Chapter 5 to the question of redundancy, but for the moment I wish to make the point that on the boat there is very little redundancy and a lot of dependency – the various parts of the boat are all dependent on and constrained by one very small piece.

Another aspect of this unequal dependence between things concerns the ways in which the front or visible parts of things often depend on back or hidden parts. The front of a house often looks neat, tidy and self-sufficient, concerned with expressing status, order, wealth and so on. It is only at the back of the house that one sees all the electricity wires, flues, gutters and outlets, the air conditioners and the communication dishes. And hidden away behind walls and beneath the floors there are the drains and sewers, the ducts and piping. Digging down we would uncover the dependencies of things. Behind the scenes there are the flows that make the front of the house possible. Things at the back service things at the front.

Front and back are connected but it is not an equal or mutual connectivity. One is visible, the other is hidden; one seems self-sufficient, the other provides for the self-sufficiency; the growth of one is constrained by the other.

We are moving, then, towards the idea that the heterogeneous assemblies or networks of connected things actually involve constraints and dependencies that lock things into particular relationships with each other. Things depend on each other not simply in the sense of relying on the contingent presence of other things but also in the more complex sense of dependency. Things are caught up in dependencies based on what is available (what the affordances are), on the non-redundant reliance on a limited number of things, on the duties and obligations associated with things, and on the sheer scale and density of the interconnected networks. Everything depends on everything else in a particular constrained way. It is thus not surprising that many scholars dealing with thing-thing interactions have used the metaphor of bindings or chains to describe the interlinking of things. Keane (2003b: 414) describes 'bundling' as the process whereby attributes of things are bound up with other attributes as a result of co-presence on the same object. Redness in an apple is found with a spherical shape, light weight, sweet taste and so on. 'Redness cannot be manifest without some embodiment that inescapably binds it to some other qualities as well, which can become contingent but real factors in its social life'. Thus redness is not a free-floating signifier; it is bound up with certain material associations and will vary with those contingent associations. While there are many accounts of enchainment (e.g. Chapman 2000, Strathern 1988) I wish to focus on two groups of approaches – operational chains and behavioral chains. In both these approaches, the focus is less on networks and more on the ways in which things are caught up in sequences, so that what happens at a point in a sequence is very dependent on what happened or will happen at another point in the same sequence.

The French School – Operational Chains

The French school of technology studies has long identified technical systems in which human bodies and things are engaged in particular tasks (Mauss 1935). In recent work a three-tiered ordering of technical systems has been identified by Pierre Lemonnier (1993a, 2012). At the first level, there are all the components of a technique whether it is coil-building a pot or tying shoe-laces or driving a car. The interacting components consist of the matter being acted upon, tools, gestures or bodily movements, sources of energy, humans and their knowledge. At the second level the various techniques are linked together in a number of ways in any particular society. For example, the techniques are linked together by the fact that one precedes another. Thus, before the coil-building can start, the clay has to be obtained, carried, pounded and mixed. Different techniques may also be linked

because they use the same tools, or the same human specialists or the same materials (for example a clay specialist might make pots and figurines). At the third level, the techniques are embedded within wider social and cultural concerns such as gender relations, ideas about matter and the cosmos, the organization of labor.

One of the most distinctive components of this French school is the emphasis on sequences of operations that follow on from each other and thus enchain human-thing actions. This focus on operational sequences derives from Marcel Mauss' (1935) discussion of *Techniques du Corps* and the work of André Leroi-Gourhan in *L'Homme et la Matière* (1943) and *Milieu et Techniques* (1945).

The *chaîne opératoire* is made up of bodily movements that incorporate both reflective knowledge (*connaissance*) and practical skills (*savoir faire*). It also includes the sequences by which materials, tools and sources of energy are involved in the transformation of matter. The approach has been applied in particular to stone tool technologies (e.g. Pelegrin 1990) and it has been used effectively in very large numbers of studies of a very wide range of technologies (Lemonnier 1993a). Usually there is nothing to indicate where an operational sequence begins or ends. The felling of a tree could be said to start with the manufacture of the adze that makes it possible (Lemonnier 2012). As already noted, the connections of things are always open.

Despite the emphasis on social technologies in this French school, it has been criticized (e.g. Sillar 2000, Skibo and Schiffer 2008) because in practice it often focuses only on a series of operations from raw material to finished product. This isolates the object from other technical and social areas. The full interconnections need to be studied. Sillar's own work is a wonderful ethnographic account of the embedding of pottery making in social, ritual and economic life in the Andes. The mining of clay, the processing of the clay by pounding, grinding, sieving, the forming of pots, the drying, the scraping, decorating, wiping and burnishing of the dry pot surface, and the firing of pots using dung fuel are all steeped in technical, social, ritual knowledge and practices. Lemonnier (1993a, b, 2012) provides many examples of a thorough embedding of technologies at the third level described above, and as a result there is considerable emphasis on the variability of technical systems in different cultural milieu. 'All techniques are thus simultaneously embedded in and partly a result of non-technical considerations' (Lemonnier 1993a: 4). In one example, Creswell (1993) conducts a study of water mills. Many of the components in the water mills are largely determined by the engineering forces produced by water and wheels. He compares water mills in which the blades are set into the vertical milling shaft at an angle and those in which the blades are set in horizontally. Creswell studies the forces of the water on the blades set at different angles and the resulting efficiencies of the turning of the mill stones. Thus 'for the rpm to increase by some 9 per cent the diameter of the bore rises by 50 per cent, and therefore the section of the flow increases by 224 per cent' (Cresswell 1993: 195). But it is not only such factors that are identified as determining the use of water mills with different blade angles. There are also social issues involved such as whether the production is for domestic or commercial use.

The focus on chains in this French school is a useful antidote to the focus on the human dependence on things seen in material culture and materiality studies in Chapter 2. Things depend on other things in sequences. Tasks have to be completed in order. There is thus a need for scheduling, and the relationships between things are not equal. Everything depends on everything else getting done, but some things have to be done first. Others have to wait their turn. There are bottlenecks and hold-ups. The temporality of things gets drawn in. It takes time for the clay to dry, the food must be cooked before it goes off, the crops must be harvested before the rains come. In all these ways things are stacked up in relation to each other, constraining each other, creating dependencies.

Leroi-Gourhan (1943, 1945, 1964–65) argued that the linking of things in technical systems had a tendency, a *tendance*, to move in a certain direction. Thus one might argue that because flint tools have sharp edges, their use will, regardless of cultural differences, lead to the addition of handles. 'La tendance … pousse le silex tenu à la main à acquérir un manche' (1943: 27). The universalist and teleological nature of this thinking makes it unpopular today but I will argue in Chapters 6–8 that within specific webs of things and humans it may indeed be the case that things and ways of doing things converge on solutions that are appropriate within specific contexts (see also Baudrillard, 1996). It may be possible to salvage the idea of *tendance* by jettisoning its universalistic overtones. Indeed, Leroi-Gourhan had an opposing notion of the *fait*. The *fait* is the unpredictable working out of the *tendance* in a particular place and time. As I have emphasized above in the discussion of the open-ness of technical processes, the particular fact is an unstable compromise between the *tendance* and the milieu. The attraction of the notion of *tendance* is that it focuses on the interactions and fits between technical acts. There is a tightness to the interactions between things that is in large part produced by the ways in which thing processes have to fit together in sequences but that is also produced by the ways that things have qualities that object, stand in the way, and thus constrain what can be done.

Behavioral Chains

Another set of approaches to the chaining of things in sequences is found in the Behavioral Archaeology of Michael Schiffer and his students. These studies are parallel to the French school in that the behavioral chains are similar to *chaînes opératoires* (Skibo and Schiffer 2008). Within the behavioral chains there are activities consisting of a series of interactions or performances. The 'performance characteristics' are the 'capabilities, skills, or competences that material culture and people must have to perform their functions' (Skibo and Schiffer 2008: 29). These interactions and performances are thus equivalent to the first level defined by Lemonnier (see above). The cluster of interactions in an activity are seen as

organized or sequenced into behavioral chains with the stages of procurement, manufacture, distribution, use, maintenance, repair and discard (Skibo and Schiffer 2008). These sequences are equivalent to Lemonnier's second level. And parallel to his third level, Schiffer (1999; see also Skibo 2009) is at pains to emphasize that social, ritual, ideological and other factors enter into behavioral chains and interactions. In this way Behavioral Archaeology absorbs the social focus of technology studies more widely.

Schiffer's emphasis on 'performance characteristics' includes a broad range of capabilities of things and humans, but it has most distinctively led to detailed study of how the material characteristics of, say, a pot enable certain tasks to be fulfilled, and in this way it is similar to Gibson's notion of affordances described above. In discussing performance characteristics Schiffer argues that, for example, 'a cooking pot must have high thermal shock resistance to withstand repeated placement over an open fire without cracking' (Skibo and Schiffer 2008: 12) – thus the potter might have to add more temper, or different types of temper or make thinner walls to make sure the pot will not crack over a fire. Schiffer *et al.* (1994; see also Schiffer 1990) conduct a series of experiments in order to examine the relations between surface treatments on pots and the performance of the pots in cooking. They find that surface treatments like texturing, organic coatings, and smudging have marked impacts on ways in which cooking pots crack and spall. Sometimes cooking pots use organic temper which is less efficient in terms of heat transfer than mineral temper, but experiments demonstrate that organic tempered ceramics have superior performance characteristics during manufacture (Skibo *et al.* 1989). Thus organic tempered pottery is more appropriate for situations in which manufacture is expedient and there is not great pressure on cooking speed and efficiency. We see then that in order to understand such interactions between clay, temper, fire, hearth, food, etc., what Sillar and Tite (2000) call 'embedded technologies', archaeologists conduct experiments that replicate past cooking and firing practices.

Thus the study of performance characteristics concerns the interactions and affordances between things in relation to a task or goal. Such studies, involving experimental archaeology, are of great importance as we try to move towards the object character of things – the way they stand up to and contribute to the way of being human. Schiffer's work demonstrates that large scale social processes run into the ground of objecting materials. As social groups living in houses form alliances through the distribution of cooked food, so their abilities to do this are based on the links between things, how organic temper responds to fire, how a burnished pot surface allows more food to be cooked in a given time. Things are bound together functionally, in relation to goals.

There are many other studies of this type, exploring the functional links between things. Lyons and d'Andrea (2003) conduct an ethnoarchaeological study of the use of griddle cooking technology in highland Ethiopia. They explore the functional relationships between the use of ovens and griddles and the presence or absence of gluten in bread ingredients. Gluten is only found in Near Eastern

cereals. Glutenins and gliadins are storage proteins in the starchy endosperm of cereals such as wheat. The storage proteins in wheat are very active so that when mixed with water and kneaded the glutenins and gliadins become hydrated, forming gluten. When dough ferments carbon dioxide is produced and this gas gets caught in the gluten and so the dough expands. Dough that is both viscous and elastic is well suited to cooking in ovens. The dough can be formed and stuck to the walls of the oven where it cooks for some time. Leavened loaves are thicker, requiring sustained high heat and longer baking times than flatbread. Griddles, or flat surfaces above a heat source, are used to bake bread made from starchy ingredients with no gluten across Africa, the Americas, and Australia. Flat cakes or flat breads are produced from tef, maize, manioc, sweet potato, acorns and other nuts. So we see here that the organic chemistry of plants, and interactions between flour, water and bacteria can be linked to the use of ovens and griddles in different parts of the world. Things are linked together functionally in terms of the goal of making bread from plants and although Lyons and d'Andrea demonstrate that other social factors, including gender relations, are involved in technological choices regarding the use of ovens or griddles, there are affinities, affordances, dependencies between things that also play a role. The chemistry of things enters into and creates seams of connection and dependency within the human web.

But there is another type of dependency between things that, as in the French school, is of great significance in the work of behavioral archaeologists. This is the sequential staging of things in chains. The activities just discussed, with their networks of interactions, are themselves ordered in series. The behavioural chain is the progression of a series of interactions (Figure 3.5). Thus in using coils of clay to make pots in Kenya, the sequenced activities might involve collecting clay from ant hills, putting clay in a container, carrying the container to the work area, spreading out the clay on a skin, pounding the clay with a stone, shaking the skin to sort out finer particles, mixing clay and water, hand forming the pot's base, making coils by hand, using hands to join and smooth the coils, using a piece of calabash to smooth and thin the walls of the pot (Schiffer and Skibo 1997: 29, see also Hodder 1982).

Things and activities at one point along a behavioral chain will have an impact on other points. 'Technical choices usually have tangible effects on an artifact's formal properties, and these effects can persist during subsequent ("downstream") activities' (Schiffer and Skibo 1997: 31). For example, the choice of organic or mineral temper for the clay of a pot will affect the clay's performance during manufacture. It will also affect the efficiency of the pot in cooking use. And it will affect the likelihood of damage, breakage and ultimately the likelihood of abrasion once discarded and surrounded by soil matrix. The human making the pot thus becomes constrained by all these downstream factors. The potters knowledge of the performance characteristics of different materials down the line, will affect her decisions as she aims at certain goals. The artisan

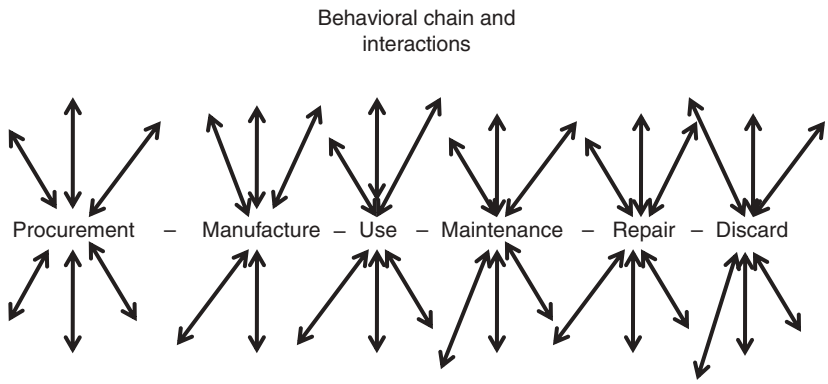

Figure 3.5 Interactions occur at all stages along behavioral chains (Source: the author).

makes compromises between different situational demands, political, social, religious and so on. These demands include the materials and their chemistry.

A common archaeological example of dependencies along behavioral chains is the work on procurement, where the obtaining of certain types of stone (for stone tools) has an effect on what types of tools can be produced and what types of task can be taken up. For example, using ethnographic examples from Australia and archaeological examples from the United States, Andrefsky (1994) has shown that the availability of lithic raw materials has an important impact on stone-tool production. As might be expected, poor quality materials tend to be manufactured into informal tools whereas high quality lithic raw materials tend to be made into formal tools when such materials are rare. The quality and abundance of raw materials will also have an impact on the practical and social uses to which the tools can be put, the extent to which they can be exchanged (with tools made of lower quality materials less likely to be widely exchanged), their rate of loss and deposition. Webb and Domanski (2008) have similarly shown that in Australian prehistory the mechanical properties of silcrete strongly influenced raw material selection and the types of tools made. For a similar discussion of the effects of raw material along the behavioral chain of metal axe production see Kienlin *et al.* (2006).

Skibo and Schiffer (2008: 111) discuss the 'dependency relationships' between activities and things. They define such relationships as the ways in which 'two activities are coupled to one another through material flows (inputs and outputs)' (Skibo and Schiffer 2008: 111) and so in the terms used in this book these would be dependence relations. We have seen that in Behavioral Archaeology as in the French school of social technology studies there are two forms of these dependences. One concerns the networks of interactions in which things, humans, knowledge, energies are entwined. The other concerns the sequencing of things, humans, activities along behavioral chains. In both cases there is a complex skein of thing-thing relations that draws in humans. The links

between things are not just interactions. And they do not just consist of dependence. There is reliance and contingency certainly, Leroi-Gourhan's *fait*. But there is also a tangled stickiness – a dependency in the sense of an unequal and constraining force. Things and their interactions only afford certain types of behavior. Given certain goals, some things are more key than others. Different things have unequal performance characteristics, different potentials. Thus the dependences and dependencies in thing-thing relations pull, channel and constrain humans and their goals. And in particular the sequencing of things and activities chains things to each other, schedules lives, frames perspectives, orders change.

Conclusion

> 'The thing has a history: it is not simply a passive inertia against which we measure our own activity. It has a 'life' of its own, characteristics of its own, which we must incorporate into our activities in order to be effective, rather than simply understanding, regulating, and neutralizing it from the outside. We need to accommodate things more than they accommodate us. Life is the growing accommodation of matter, the adaptation of the needs of life to the exigencies of matter.'
>
> (Grosz 2005: 132)

I hope in this chapter that it has become clear what is missing in the approaches described in Chapter 2. I trust it has become clear where the gap is. It is fascinating indeed to explore how humans give meanings and agency to things. It is important to recognize that humans can only act, think, 'be' as a result of their dependence on things. But the things themselves, in their interactions with each other, play an active role in the mix. We have begun to see the objectness of things, their chemistry, their forces, their interactions. We have started to take things more seriously.

In so doing there has been use of social theory, but there has also been increased reference to analytical science, experiment and ethnoarchaeological study of materials. These latter areas are often thought to be rather removed from theoretical debate. Radiocarbon dating, sourcing of ceramics and lithics using X-ray diffraction, chemical analyses of stable isotopes in order to determine diet are all surrounded in debate, but the debate is usually seen as rather separate from the intellectual currents in anthropology and the human and social sciences. In archaeology much analytical research is published in the journal *Archaeometry*, not usually noted for its theoretical debates. However, recent attempts have been made to bridge the gap between analytical science and theories of material agency and materiality. In 2002 Andrew Jones published a book followed up by an article in the journal *Archaeometry* in 2004 aimed at raising debate about the relationships

between theories of materiality and the analysis of materials. He argued for the potential for a rapprochement between social theorists and archaeological scientists.

In the resulting debate in *Archaeometry* 47 (2005: 175–207), a number of commentators agreed that the archaeological sciences should be important and relevant in the context of theories about materiality. In contrast to the earlier focus on representation, the shift to materiality studies should surely draw in the scientific analysis of things eagerly. For example, the new archaeological interest in colour grew out of phenomenological theories, but the analysis of pigments depends on scientific analytical methods (Jones 2002). And yet, as Julian Thomas points out in his contribution to the *Archaeometry* debate, most studies of materiality deal with the social processes by which the material world is revealed to human beings. 'Consequentially, when archaeological theorists speak of materiality and materials scientists talk of material characteristics, they are not discussing the same thing' (Thomas 2005: 200).This is the gap to which I referred in Chapter 2. In this chapter I have argued we need to go beyond accounts of materiality to look at the objectness of things and the dependences and dependencies of things on each other, all of which draw humans into a skein of tangled, sticky or tightly woven relations. It is not enough just to say (as we did in Chapter 2) that humans depend on things, give meaning to things, use things, gain identities from things, own things – because the things themselves are closely connected to other things in ways that draw humans in. Things are constrained in far-flung networks within which some things are more key than others and within which there are dependencies and inequalities. Things are organized into sequences and humans get drawn into these chains, waiting for one thing to happen before another step can be taken.

This is not a return to materialism because we have seen that things are connected to each other in equipmental totalities, technical systems that only work in relation to some goal. As I said at the start of this chapter my aim has not been to talk of things shorn of humans. Humans and things are tied together from the start. The objectness of thing-thing relations is not determining; it simply works within and alongside humans, their goals and aspirations. Things are not isolated, inert. They are involved in complex flows of matter, energy and information. They need each other, depend on the presence and timing of each other. They are chained together. Humans are involved in these chains from the start. And they remain pulled into the links and interstices. Humans depend on things and so they become embroiled in the dependences and dependencies between things. The chains may spread out in open, unbounded, and thus uncertain ways, but at the same time the links of the chain are closed shut, locking humans and things together. It follows, therefore, that study of materiality without materials science is inadequate. The types of approach described in Chapter 2 need to be linked with analytical and experimental work on the objectness of things and their inter-dependences.

Çatalhöyük in the Neolithic of the Middle East

Çatalhöyük is a 21m high mound containing traces of habitation in central Turkey between 7400 and 6000 BC, although an adjacent mound (Çatalhöyük West) continues into the mid 6th millennium. The site was first excavated by James Mellaart (e.g. 1964, 1967) and more recently by an international team (Hodder 1996, 2000, 2005a, b, 2006a, b, 2007a, b). At its maximum size the settlement or 'town' extended over 13 hectares and may have held 3 500 to 8 000 people (Cessford 2005). The main levels at the site have been dated by radiocarbon as shown in Figure 3.6 (Cessford *et al.* 2006). Throughout the sequence houses are built up against each other so that there are no streets and people moved around the settlement on the rooftops. Humans were buried beneath the floors of houses, and the insides of houses were furnished with paintings, relief sculptures and installations of bull horns, bear teeth and pig jaws. While there is some variation between more elaborate houses that have more burials and are rebuilt more times (termed history houses) and less elaborate houses there are no distinct ceremonial or chiefly centers or public or administrative buildings that have so far been found (despite intensive survey and sampling). Çatalhöyük consists simply of houses and areas of refuse or midden between them.

While there is much stability and continuity through time at Çatalhöyük, with houses built directly on houses and with much consistency in their internal layout (Hodder 2006b, Düring 2006) there are also gradual changes through time. In the earliest levels there is little if any use of pottery which appears in Levels XII to X. Cooking pottery emerges in Level VII and there is at the same time a shift to the use of sandier mud bricks. Levels VII to VIA and VIB see the greatest density and packing of houses. This is the period in which the maximum number of paintings and installations are found in houses. After Level VIA there is somewhat of a break, with houses less consistently being rebuilt, the emergence of larger and more elaborate houses with more evidence of storage and productive activities, stamp seals and a greater range of pottery types. From Level VI/V, lithic technology becomes blade rather than flake-based, and there are less installations in houses and more paintings of narrative scenes. While there is much continuity throughout the sequence in a subsistence economy based on domesticated cereals and domestic sheep and goat and a range of wild fauna (including wild cattle), in the uppermost levels (especially after Level V) there is some evidence for domestication of cattle (certainly by the time of the West Mound) and more intensive use of the secondary products of sheep and goat.

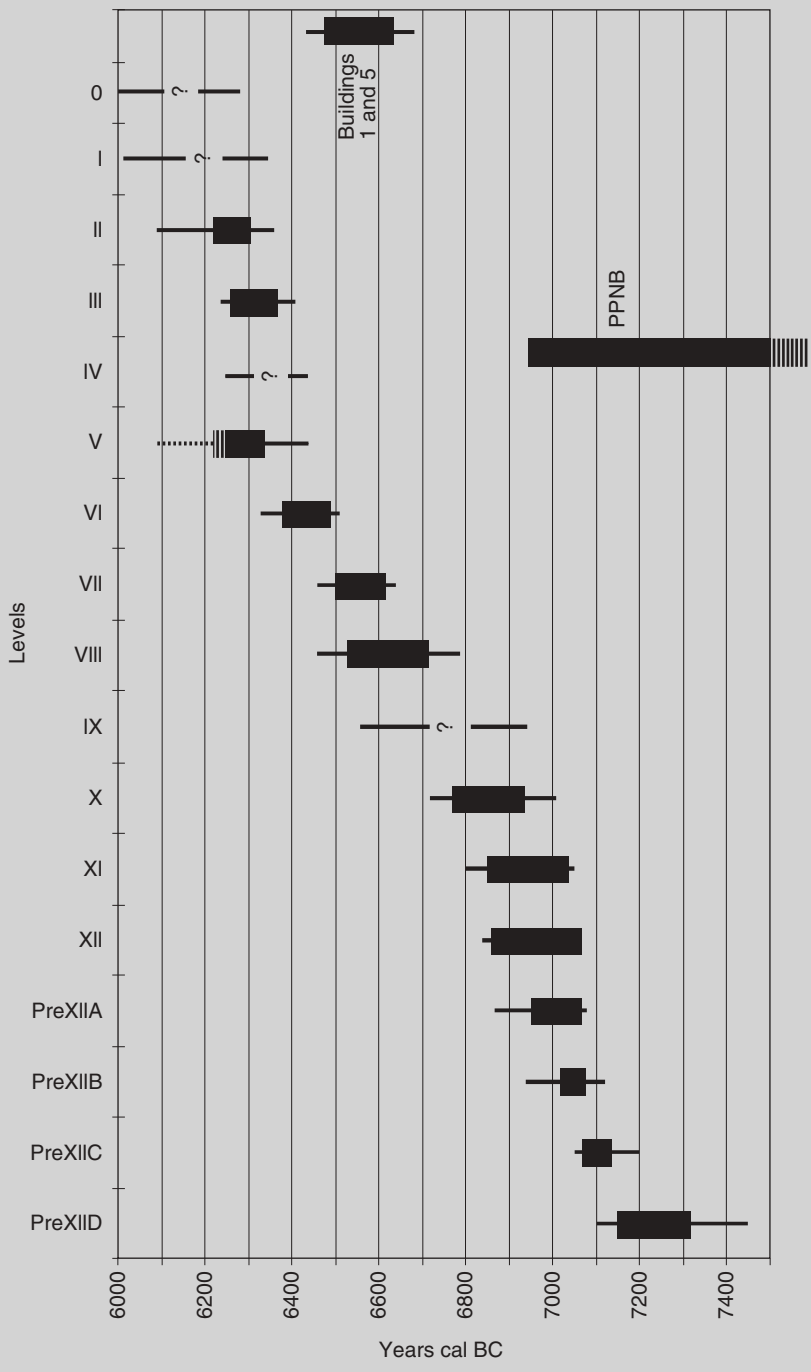

Figure 3.6 The levels at Çatalhöyük dated by radiocarbon (Source: Cessford *et al.* 2006).

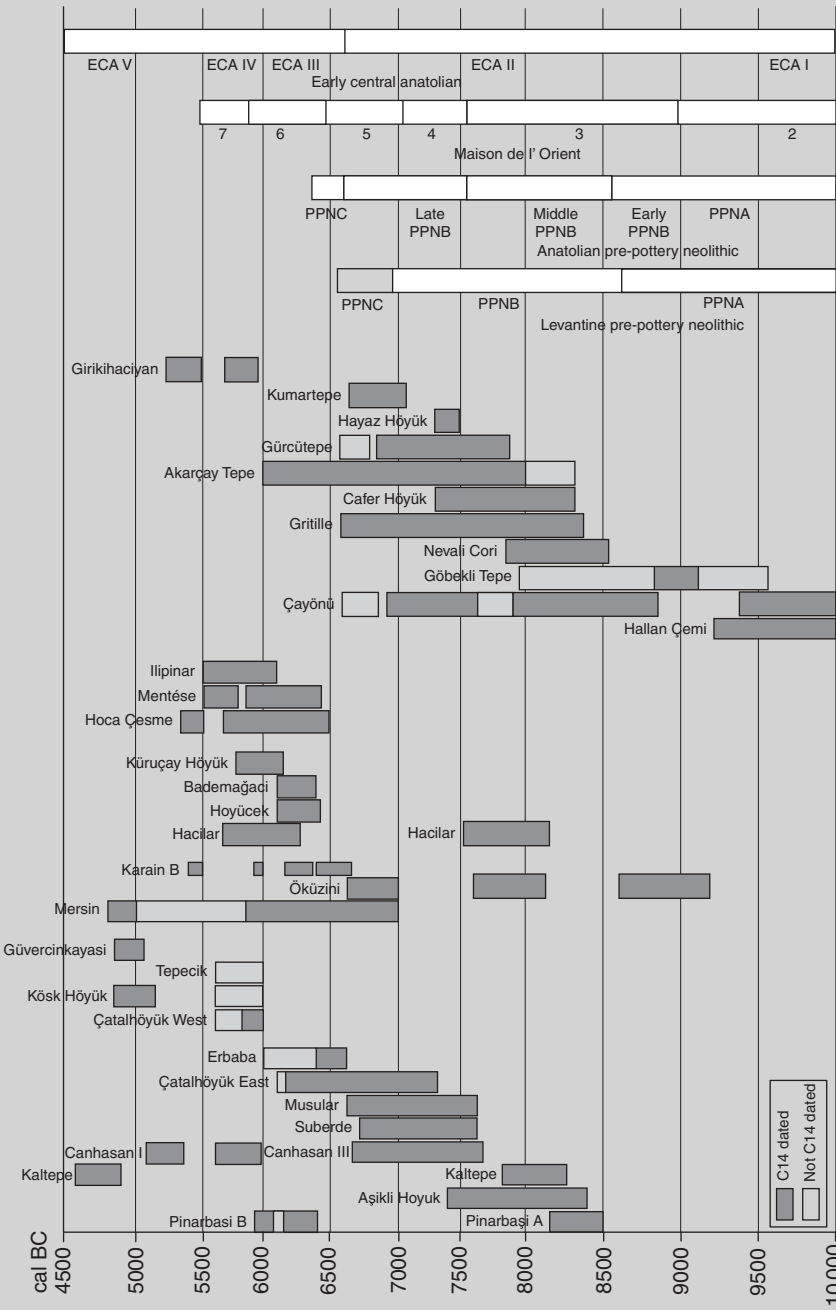

Figure 3.7 The dating of Çatalhöyük in the context of other sites in Turkey and the Middle East (Source: Cessford *et al.* 2006).

In terms of the Levantine sequence in the Middle East, Çatalhöyük is placed towards the end of the PPNB/C sequence and parallel with the Pottery Neolithic (Figure 3.7). Intensified use of morphologically wild plants and animals associated with some degree of sedentism is evident by the time of the Natufian (see Chapter 9). Settled villages of mud-brick and stone houses appear in the PPNA but it is not until the PPNB that the full range of domesticates can clearly be attested, associated with substantial double-storey houses, intra-mural burials and a wide range of symbolism and art, both in houses and in clearly ritual or cult buildings (Bar-Yosef 2001, Kuijt and Goring-Morris 2002). Sites such as Göbekli Tepe in southeast Turkey/northern Mesopotamia demonstrate many differences with the southern Levant suggesting that a poly-centric account of the development of the Neolithic in the Middle East is needed (Özdoğan 2002).

Chapter 4
Things Depend on Humans

My image here is of getting on a plane, sitting in my seat, and then being told of a delay in departure because of metal fatigue or electrical faults. Maintenance men in yellow coats, electricians, engineers start walking up and down the aisle, disappearing into the hidden recesses of the plane. The men cannot fix the fault and so in the end I am allowed off the plane into the ensuing chaos. What has been set in motion by the plane's fatigue is the large elaborate network of people and things that care for the plane and keep it from causing accident and death. There are part manufacturers and part distributors. There are institutions like insurance companies and investors in aviation stocks and shares – all involved in the likelihood of the plane crashing. And yet in the end the plane wins out. I miss my connection, and am not there to give my lecture. As I wait for another plane home, I ponder on how much of my life is involved with people who keep things and bodies going – garage mechanics, plumbers, electricians, cable and broad-band providers, software code writers, gardeners, doctors, vets.

At one level it is a tautology to say that things depend on people because since the start of Chapter 2 I have concentrated on those things which are solid entities made by humans. It is obvious that things depend on the people who make them, use them, repair them, discard them. Things depend on humans all along the behavioral chains and throughout their use lives. In this chapter I will include domesticated animals and plants as things made by humans, and again it is self-evident that animals and plants that have been made domestic depend on humans.

And yet there is an emphasis that needs to be added here. There is an oft-expressed assumption in anthropology and the social sciences that things, objects, are stable and fixed. For example, Michel Serres (1995: 87) wrote 'Our relationships,

Entangled: An Archaeology of the Relationships between Humans and Things, First Edition. Ian Hodder.
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social bonds would be airy as clouds were there only contracts between subjects. In fact, the object … stabilizes our relationships'. Following Serres, Olsen (2010: 140) argues that things produce 'stability, concreteness, and security' (see also Latour 2005). 'Things shape the temporal structures, allowing for social order to be stabilized and reproduced' (Preda 1999: 347). We seem to think that the things themselves are fixed while the meanings we give to them swirl and change. While this may often appear true in the short time-span of ethnographic enquiry, from an archaeological perspective things seem transient, always changing, problematic, unbounded. As noted in Chapter 1, things are not inert. Things are always falling apart, transforming, growing, changing, dying, running out. We know about the constraints on humans from the material world, at least in the Marxist sense of the dialectic between the relations and forces of production, or we know about environmental determinism, ecosystem constraint and so on. But at the scale of those living in societies and institutions, there is also the need to deal with the impermanence of things.

A 300-year old sandstone church may seem very stable. And yet in his study of such a church in Manchester, Edensor (2011: 238) describes matter as 'continuously emergent'. He follows DeLanda (2006) in focusing on entities such as the church as heterogeneous assemblages that are fluid and never stable, full of relationalities and potentialities. Matter, labor and knowledge circulate through the building. Even what appear to be inert objects are made up of the spin of microscope particles which will eventually split, decay and transform. Some of the agencies that interact with the supposedly solid and obdurate stone of the church to transform it are the weather, air pollution, rising ground water, impact from metal supports and attack from micro-organisms. The result of all this is that new connections and networks are needed to supply stone that can replace the ailing parts of the church, and maintenance workers and technologies are brought into play, including new conservation technologies such as lasers, ultrasound and heat lances. When problems will emerge is very unclear – stone blocks suddenly start falling off the tower despite regular inspection and planning. The multiplicity of complex interactions creates emergent problems.

The walls made of unfired mud brick at Çatalhöyük provide another example. We have put the walls of houses on display. They appear solid and timeless; after all they have stood for 9000 years. But this appearance of permanence is an artifice of the massive use of chemicals, consolidants and grouts inserted by our conservators. Our team is in an endless daily struggle to keep the walls up (Figure 4.1). We find the walls leaning at dizzying angles. Mellaart had found the same thing. Talking of VIB and earlier walls, he wrote (1964: 39) 'walls leant at drunken angles, developed large cracks upon drying, and were a menace all round'. The people at Çatalhöyük had the same problem.

This instability is the nature of unfired, sun-dried clay – but it is especially true of the smectitic clays used at Çatalhöyük. Chris Doherty and others doing the archaeometric work on the materials and environments of Çatalhöyük have

Figure 4.1 The walls at Çatalhöyük did not stay upright (Source: Çatalhöyük Research Project and Jason Quinlan).

begun to build up a picture of how these clays were used. Smectite-rich soils are found in many semi-arid environments which have a local volcanic geology. Çatalhöyük is in a semi-arid zone and the site is surrounded by alluvial soils that derive from volcanic regions to the southwest. We know these alluvial soils were used for building houses – as demonstrated by the extraction pits by the site. Smectites are prone to very quick expansion with water, and very high shrinkage when dry and this property continues when they are used as constructional materials. The relationships between molecules in the clay produced relationships between people in society at Çatalhöyük as they worked together to solve the problem of collapsing walls.

People in Neolithic Çatalhöyük dealt with the problem in a variety of ways. For example, they supported the walls with large wooden posts; they also recruited the ancestors to hold up the house – in Building 6 a human skull was placed at the bottom of a post. But they also had other solutions such as frequently covering the walls in a plaster layer (we have found up to 450 thin plaster surfaces on one wall) and doubling walls (adjacent houses do not share walls; rather walls are built up against or support each other). During the occupation of the site, large trees for

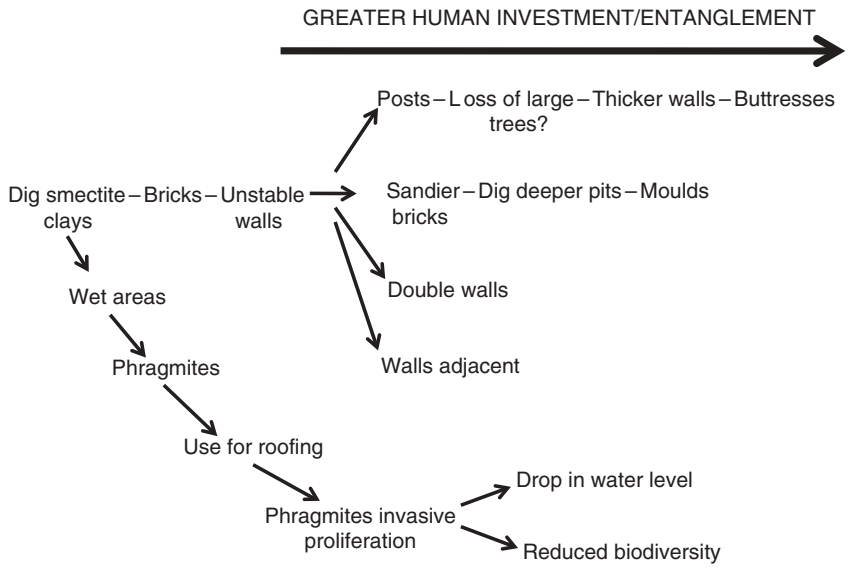
GREATER HUMAN INVESTMENT/ENTANGLEMENT
Posts – Loss of large trees? – Thicker walls – Buttresses
Dig smectite clays – Bricks – Unstable walls
Sandier – Dig deeper pits – Moulds bricks
Double walls
Wet areas
Phragmites
Walls adjacent
Use for roofing
Drop in water level
Phragmites invasive proliferation
Reduced biodiversity

Figure 4.2 Sequences of entanglement resulting from brick making at Çatalhöyük (Source: the author, Chris Doherty and Philippa Ryan).

making house posts disappeared from the area (perhaps through over-use, or because of human-induced ecological change). One solution was that people started making thicker walls with bigger bricks and getting sandier clays. The greater use of sand made the smectite more stable. In the end, right at the top of the Neolithic mound, in Levels I-III and on the following Chalcolithic West mound (6000–5500 BC on the other side of the river) internal buttresses were added to give increased support (Marciniak and Czerniak 2008, Biehl and Ravenstock 2009, Erdoğu 2009).

The use of sandier bricks involved digging deeper into the ground (Doherty pers.comm.) and the deeper extraction pits changed the environment around the site and increased the formation of colluvium. But the use of sandier clays allowed shifts in brick technology and people changed from making bricks by laying wet clay directly on walls to making thicker bricks with the use of moulds. The use of moulds involved a more complex technology, and the laying out of bricks to dry implies making bricks in advance of construction and probably off site. Brick manufacture would thus have to be scheduled in relation to other activities. Making stronger and more stable bricks involved greater labor and work scheduling. So people increasingly got trapped by bricks at Çatalhöyük (Figure 4.2). Dealing with smectite led to various implications that increasingly trapped people in further relationships with things.

The bricks and other human-made artifacts entrapped people in long-term relationships of material investment, care and maintenance. A related example has been identified by Philippa Ryan (pers. comm.) in her work on the phytoliths from

Çatalhöyük. The exploitation of the reed *Phragmites australis* in the area around Çatalhöyük led to an aggressive proliferation of this species in wetter areas. The proliferation of the *Phragmites* near the site may initially have been encouraged by the digging of pits for clay extraction that filled with water (Figure 4.2). The exploitation of this plant for roofing and other functions led to invasion by this plant with a resultant lowering of the water table and a competitive expulsion of other species (perhaps including trees). Thus an unintended outcome of the winning of clay from pits may have been the expansion of an aggressive plant that proliferated near the site and would have had to be cut back in an endless battle in order to allow continued dependence on the local wetland resources which were an important part of the Çatalhöyük diet. Humans were forced to invest more in order to stay in the same place.

Things Fall Apart

Things do have a primary agency, not because they have intentionality but because they are vibrant and have lives and interactions of their own. As they grow, transform or fall apart they have a direct impact on human lives. This is not a secondary agency delegated to things by humans (Gell 1998, Latour 1996). The falling apart of things draws humans into their care. This dependence on maintenance can have widespread and dispersed connections, as we would expect given the dispersed nature of all thing-thing interactions (as seen in Chapter 3). I want to illustrate the extent of these connections around maintenance with another type of wall. In the north of England vast areas of grazing land in the Yorkshire Dales are divided by dry-built stone walls that cross valleys, meadows and hill tops. The skills involved in making walls of undressed stone without mortar or fill are considerable. The wall surfaces slope in slightly, and there are longer stones that tie both sides of the wall together. But the main skill is in the selection of stones so that they bed down together, producing a stable and long-lasting wall.

Stable as they appear to the casual passer-by, the walls are a nuisance in that they frequently start to collapse as wind and rain disturb them and as sheep and walkers try to scramble over them. Their maintenance depends on those with the requisite training and experience, and with the contacts with sources of new stone. But the maintenance of the Dales walls does not just depend on some skilled craftspersons and their access to suitable stones. We can see this in the fact that today there are few people in the Dales who still have the requisite skills to make dry-stone walls. And many walls are now left unrepaired or replaced by barbed or electric wire fences. All this suggests there is a whole system that keeps the walls up, not just some craftspersons.

Traditionally the dry-stone walls of the Dales were part of a mixed farming system that developed since Iron Age and Roman times. The walls identified boundaries

between grazing and arable fields, between private and common pasture, and between roadways and fields. Today the landscape is dominated by heavily-subsidized sheep farming, maintained by European regulations and grants. Large-scale supermarket chains such as Tesco now condition farming methods as they have pushed down prices and imposed their own expectations of product quality. Many parts of the Dales are also seen as heritage landscapes worthy of maintenance in their own right. The National Trust now cares for large swathes of the Dales imposing sensitivities tinged with nostalgia for rural ways of life, organic foods and the resurrection of traditional flowering meadows in which no insecticides are used. That the walls are maintained today thus depends on a fragile alliance of European regulations, big retail business and national conservation. The falling dry-stone wall needs a person and an expertise to keep it up. It forces people to attend to it, to care for it. And they do so, because of a widespread and dispersed tangle of interests.

During the Enlightenment new things emerged as they came to be seen by new instruments and machines. The microscope, telescope and the air-pump allowed new things, new phenomena to be brought into view. These new things, stars, microbes and vacuums depended very much on humans. By being identified they were brought into relations with new connections and possibilities. As noted at the start of Chapter 2, the air-pump used by Boyle allowed new things to be seen (Shapin and Schaffer 1985: 26). The pump sucked air out of a glass globe so that experiments could be conducted in a vacuum. But the air pump needed a particular type of human-thing context if it was to survive. 'Scientific instruments therefore imposed both a correction and a discipline upon the senses. In this respect the discipline enforced by devices such as the microscope and the air-pump was analogous to the discipline imposed upon the senses by reason' (Shapin and Schaffer 1985: 37). Getting the air-pump working required a lot of effort and organization. 'Establishing matters of fact did require immense amounts of labour' (Shapin and Schaffer 1985: 225). In particular, the air-pumps kept breaking down. All the air-pumps built in the 17th century were 'always in trouble, either directly because of leakage or indirectly because of rival attacks' (Shapin and Schaffer 1985: 229). There were, as a result, very few pumps working at any moment. The air-pump depended on humans not just to make it and use it, but also to keep it going.

So within the more general notion that things depend on humans I focus on the idea that the behavior of things, plants and animals traps humans into various forms of care, regulation and discipline. Things cannot reproduce and therefore cannot exist without humans. Of course, a house that has fallen down still exists. And domesticated species can revert or go feral if untended. So it is more that things cannot exist for humans, in the ways that humans want, without human intervention. Things depend on humans and this dependence draws humans in, sometimes seems to lock them in, to specific forms of behavior – a human behavior adjusted to, even at times regulated and disciplined by the behavior of things. Resources, wild or domesticated, animate or inanimate, need tending, conserving, protecting if they are to exist in the ways that humans want them to.

It is in the nature of things that they break, get dirty, decay, disperse. Even small things falling apart can have large consequences (as is seen in the 1958 [1994] book by Chinua Achebe). So things need people to maintain them in the forms that they require them. Objects have to be conserved, cleaned, repaired, looked after. The things require maintenance, energy input, and they themselves depend on other things and people. Archaeologists are good at exploring this type of knowledge. They have built up much knowledge about costs, labor, distances, access, skills needed to maintain things. They are good at assessing labor input into technologies and their relative efficiencies in different environments. They are good at decay, maintenance, breakage, loss, repair, deposition, sequence even if specialism in knowledge about such areas is sometimes seen as not contributing much to archaeological theory.

Behavioral Archaeology and Material Behavior

I have focused so far on one aspect of the behavior of materials – that they fall apart and transform and so draw humans who need them into their care. But there is a lot more to the behavior of materials that draws people in. In Behavioral Archaeology as was noted in Chapter 3, the stages of human use of materials include procurement, manufacture, exchange, use, discard. Throughout the lives of things they draw people into labor and involvement. In particular, the facts that things are not inert and are not isolated involve humans. There are many examples. A species will die out unless maintained by humans and a lake will dry up as surrounding soils are deforested. A pot has to be fired to exist and has to be looked after so that it does not break. A computer has to be turned on. We need not, and should not, assume a 'telos' here. I am not saying that the pot intends to reproduce itself by depending on humans. That would be a fallacy. But the existence of these things in a specific form draws people into their care and into the lives of things.

We can return to the examples described in Chapter 3 from the point of view of thing-thing interactions. Fire gave a lot to humans – warmth, energy, light, cooked food and from early on we know that the fire became a hearth around which social activities and stone tool reduction took place. Human use of fire dates from the Lower and Middle Pleistocene (Goren-Inbar *et al.* 2004). Kebara cave in the Middle East has deposits which span from the Middle Palaeolithic through to Natufian, or from roughly 60 000 to 10 000 BC. The Middle Palaeolithic deposits show repeated use of part of the cave for hearths, while an inner part of the cave was used as a dump area (Goldberg 2001). The hearth area has deep deposits of overlapping hearths, each of which results from several episodes of combustion (Meignen *et al.* 2000: 14). These multiphase hearths indicate long periods of repetitive use in the same depression (Meignen *et al.* 2000: 15). All this implies investment and labor since the fire depended on having a fire pit, and it needed fuel, and it needed

someone to watch over it and keep it going. Humans had to feed the fire. In doing so they became involved in labor and schedules set by the fire. One of the most fascinating insights offered by the discovery of the prehistoric Ötzi Ice Man in the Alps was his portable fire basket – in which moss was used to keep embers alive (Fowler 2001). Thus the fickleness of fire, its tendency to go out, created the need for human labor and for social regulation and self disciplining. Both Prometheus and humans had become bound.

The frequent (monthly or seasonal) replastering of the internal walls of houses at Çatalhöyük provided the inhabitants with many advantages such as light, hygiene, protection from mosquitoes, the dampening of odors. As noted above, the plaster covering the mudbrick walls (inside the walls but also sometimes outside) helped to protect the walls and keep them standing. But the absorbent smectitic clays also blackened quickly as they took up the soot from the oven and hearth in the room. So here the fire plus the plaster produced problems that humans had to deal with. The blackened plasters reduced their effectiveness in terms of reflecting light and in terms of the social and symbolic valences given to whiteness in these houses (the burial platforms in the northern and eastern parts of the main rooms of houses were kept very white – Matthews 2005). The plasters also had a tendency to crack and flake so they needed frequent replacement. Each time the walls in the main rooms and over the burial platforms were replastered white, marl had to be collected from the plain at river exposures or in extraction pits. It had to be mixed with plant material and with water in order to make the basal layer. After this had dried a second whiter layer with very little organic content could be applied, left to dry and then burnished smooth with a pebble. As noted in Chapter 3 other tools and processes were also involved. Carrying all these marls, water and materials up onto the mound would have involved a considerable amount of labor at frequent intervals (perhaps every month in the winter months). The replastering seems to have had important social and symbolic roles. The quality of the plastering is always superior in the more elaborate houses, and it tends to be finer and better applied over and around the burial platforms – very little effort is made in the side and storage rooms. So the plastering may have been seen as renewal. Replastering the walls may have been seen as linked to the replastering or refleshing of human skulls (Hodder and Meskell 2011). The need of the plaster for maintenance undoubtedly absorbed humans and human labor to a considerable degree. It forced a discipline on the members of the house as regulations, customs and traditions emerged about who did the re-plastering when and with what level of skill.

The introduction of the wheel might be seen as a straightforward labor-saving device, allowing carts to carry greater loads longer distances. Indeed the wheel became widely adopted and it has continued to be a major component of lives and economies to the present day. And yet the wheel was not adopted in the Americas before the arrival of Europeans. Toy or model wheels did exist in pre-Columbian Mesoamerica, but not real wheels on carts. This is almost certainly because of the

lack of suitable domesticable draught animals in the Americas. Roads existed, for example the Inca trails, but not the cattle and horse that could be trained to pull wheeled carts. Indeed, in Europe and the Middle East the adoption of the wheel in the 4th millennium BC is closely tied to the more intensive use of animals for secondary products such as draught and wool (Sherratt 1981). Thus the use of the wheel may have saved labor but it also depended on greater labor investment in the management of animals, their provisioning and foddering, the organization of herd structures and so on.

In all these cases, then, we see that things depend on humans and that humans get drawn into greater labor and into a variety of responses in order to keep things as they are wanted. Fire goes out so humans have to invest in ways, social and material, of keeping the fire going. Plaster gets covered in soot so we have to replaster. Wheels get us caught up in building roads and finding fodder for animals to draw carts. Foucault (1973) discussed the relationships between knowledge and power and we could say that for Foucault things are often complicit in discourses of power. The most famous example used by Foucault (1995) is Bentham's panopticon – an annular building in which from a central tower all the cells in the outer walls can be surveilled. The cells have windows on the inner and outer walls so that light passes through the cells and people in the cells can be seen by the supervisor in the central tower. For Foucault the panopticon is an idea, a paradigm that can be applied in diverse contexts such as prisons, asylums, schools, hospitals and so on. Agamben (2009) argues that Foucault's discursive formations or epistemes deal with the total formation of knowledge in relation to power. The panopticon is an example used to build a general model of the functioning of the disciplinary modality of power. One of Bentham's aims was to design a prison that was an efficient way of managing large numbers of people with minimal cost. Its design at least in part derived from functional considerations such as lines of sight, backlighting and the use of walls to isolate individuals so that group action is minimized. But Bentham's prison was never built. The design has inspired many prisons (for example, the Eastern State Penitentiary built in 1829 in Philadelphia), and it is in the practices of prison construction and use that we should look to see the workings of disciplinary power. All buildings have both a paradigmatic, ideal purpose and a lived in everydayness. The panopticon makes use of functional considerations such as lines of sight and walls to achieve its paradigmatic purpose. But in practice the building is part of a network of dependences between humans and things. The network itself is disciplinary as humans are forced to look after their individual cells, clean them out, change the linen, clean out the slops and as managers are forced to provide light, warmth, clothing, access to recreation for the individual inmates. Food, water, electricity, heat flow in, through the building and out again. These flows are managed and manipulated by warders and inmates. The disciplinary regime of individualized surveillance is produced and negotiated as humans get drawn into a particular material world.

One area in which archaeologists have developed their own theories about how things humans make or interact with force humans into various forms of labor and organization is refuse discard. The study of taphonomy (Lyman 1994) has led to increased understanding of bone breakage and deposit formation under different conditions, including human trampling or scavenging. So as archaeologists we have an increasingly sophisticated understanding of how things transform into residues and deposits. The work of Schiffer in his (1976) 'Behavioral Archaeology' (see also Schiffer 1987) has been successful in defining different forms of refuse deposition. *Primary refuse* is the intentional discard of items at or near the end of their use-life, in their location of use. *Secondary refuse* is the term used to describe the disposal of items in areas other than where they were used. *De facto refuse* is the tools and materials abandoned in an activity area but still usable. In many complex tell or urban sites it is necessary to add *Tertiary refuse,* defined as all the items of refuse that become incorporated into deposits as background constituents of the deposit matrix. Work on discard patterns has been used to explore questions such as degrees of sedentism and density of occupation, the assumption being that as societies become more dense and sedentary so they are forced (because of the build up of odors and disease and general hindrance) to organize refuse into refuse areas away from domestic habitation, into pits and ultimately, in modern urban conurbations, into rubbish tips or land fill. Other approaches to the organization of refuse have focused on its social and symbolic role (Hodder 1982, Deetz 1977). It is my aim in this volume to cut across this opposition between material and symbolic processes. Thinking about the ways in which things like refuse draw humans in provides an example.

It has long been argued (Rathje 1974, Rathje and Murphy 1992) that humans say things about their behavior that studies of their refuse contradict. Thus public statements about levels of alcohol or meat consumption can be shown to be false or inaccurate when garbage bins are examined. Whether this is a matter of *connaissance* versus *savoir faire*, or whether it is conscious duplicity is unclear. But we can assume that at some level of consciousness humans become faced with refuse build-up that forces reaction and response. Rathje and Murphy (1992) in fact suggest that a garbage crisis would have emerged as humans became sedentary. Hardy-Smith and Edwards (2004) have explored this idea in relation to the early farmers of the Middle East. At the semi-sedentary Early Natufian site (c 10 000 BC) of Wadi Hammeh 27 in Jordan there was little attempt at organized refuse disposal. By-products of artifact manufacture, bone scraps, cached items and human remains were allowed to build up close to where they were used. In fact half a million artifacts were found on interior hut floors. There was very little secondary refuse. Looking more widely in the Levant, Hardy-Smith and Edwards see initial attempts at refuse organization in PPNA (8500–7400 BC) with more consistent refuse organization in PPNB (7400–6000 BC) where internal house floors are often swept immaculately clean and well-defined external middens appear.

By the PPNB 'it was no longer possible to ignore accumulations or refuse and artefacts underfoot, particularly the razor-sharp products of lithic reduction, without suffering significant discomfort' (Hardy-Smith and Edwards 2004: 283). In some places, the provision of hard plastered floors would have exacerbated the problem, although at Çatalhöyük the floors remained soft. But the rise in frequency and duration of use of buildings, alongside changing concepts of the dead and of history and house abandonment – all this mix of material and conceptual considerations, made it increasingly important to deal with the problem of the accumulation of debris inside houses. In the PPNB, houses often ended up surrounded by piles of refuse and through time these piles themselves led to problems of management and removal. At times at Çatalhöyük refuse pits were dug and these became common in later prehistory in many parts of Europe and the Middle East. As humans became more and more dependent on things they had made in early settled villages, so they gradually found themselves having to deal with what became a massive drain of labor and energy – refuse. In dealing with the refuse they developed ideas and practices that drew them towards and away from things.

Behavioral Ecology

Another source of ideas about how the behavior of things, plants and animals draws humans into various forms of care is Behavioral Ecology. Much Behavioral Ecology takes its intellectual source from Tinbergen (1963) who was himself inspired by Konrad Lorenz to develop the following four postulates about animal behavior: that 'its short-term causation can be studied in fundamentally the same way as that of other life processes; that its survival value can be studied just as systematically as its causation; that the study of its ontogeny is similar to that of the ontogeny of structure; and that the study of its evolution likewise follows the same lines as that of evolution of form' (Tinbergen 1963: 430). Thus, behavior is seen as part of the adaptive equipment of animals. According to the first postulate, many behaviors are influenced by biology, and each animal is endowed with specific behavior mechanisms. These are proximate or mechanical explanations (Bird and O'Connell 2006). The second postulate explores how these specific mechanisms of behavior contribute to animal survival in particular settings that develop historically through time. The third, ontogenetic level of explanation, deals with change of behavior machinery during development and with the relationships between learned and innate behavior patterns. The fourth point deals with the evolutionary study of behavior, common descent or convergence. It seeks explanations that are general or universal and deal with fitness-related costs and benefits.

These different forms of causation of behavior, proximate and ultimate, short-term and long-term, historical and universal, can be applied to plants, animals and

humans in terms of adaptation, survival and evolution. From the point of view of this book, this work in ethology or Behavioral Ecology is of importance in defining the life histories and interactions of plants and animals. Through an understanding of behavior and its varied causes we can explain how humans that come to depend on plants and animals get drawn into specific behaviors themselves.

There are many ecological and experimental studies that explore the ways in which plant behavior draws humans into specific investments and responses. For example, Wollstonecroft *et al.* (2008) examine the use of sea club-rush (*Bolboschoenus maritimus*) in the Epipalaeolithic (c 24 000–12 000 cal BP) in the Middle East. 'The results demonstrate how the biologically inherited functional properties of a species interact with specific food processing techniques to promote or hinder its edibility and nutrient bioaccessibility' (Wollstonecroft *et al.* 2008: 1). During this period over 250 wild plant taxa have been identified on archaeological sites. Many needed processing before being edible. There is evidence that both fire and ground stone mortars and pestles started to be used for plant processing in the Epipalaeolithic. Hunter-gatherers were investing more in plant food gathering that led to the need for more intensive processing such as pulverizing, grinding and heat treatments such as boiling, roasting as well as washing, peeling, baking, pit-cooking, preservation and storage. The potential for nutrient release from plants is closely related of course to the biology of the plant, for example the possibility of cell rupture and cell separation. Wollstonecroft *et al.* explore the sea club-rush experimentally to see how these biological factors interact with food processing. They find that heating alone does not lead to a softening of the tuber tissue. Some pulverizing or pounding is needed to create cell rupture and separation. It is clear then that the functional properties of the different plants interact with the types of processing and labor input that are needed. Hunter-gatherers using these types of plants are drawn into certain kinds of labor and artifact production including the need to obtain sources of ground stone, or engage in exchange relationships to obtain the stone, and so on. We have already seen in this chapter the related case of the use at Çatalhöyük of the reed *Phragmites australis*. Exploitation of the reed led to an aggressive proliferation of this species in wetter areas, resulting in lowering water tables and a competitive expulsion of other species – and thus greater labor from humans in order to cut back the reeds.

Perhaps the best example of how plants that depend on humans have drawn humans into particular forms of investment and care is provided by the domestication of cereals. As Fuller (2007: 903) notes, 'domestication results from the earlier stages of wild plant food production and systematic cultivation, making crops more dependent on humans for survival but also more productive.' People 'put increasing labor effort into a single unit of land' (Fuller 2007: 903) but the payoff was increased productivity on that unit of land. Fuller examines the interplay of cultural behavior and plant genetics. 'Thus, fruit trees, vines and tubers are not "domesticated" in the same way as grain crops such as cereals and pulses, in as much as they tend to be reproduced vegetatively and to represent the human

choice of favorable mutants' (Fuller 2007: 904). Often thought to be the most important domestication trait is the elimination or reduction of natural seed dispersal, for example the appearance of non-shattering rachis in cereals or non-dehiscent pod in pulses. This 'makes a species dependent upon the human farmer for survival' (Fuller 2007: 904). But this means the addition of human labor (threshing and winnowing) and then dispersal of seeds by the farmer (Fuller *et al.* 2010). Once the tough rachis had been selected for, the plants depended on humans for their regeneration. Wheats and people had become involved in a co-dependency relationship. The reproduction of wheat came to depend on our continued intervention. We obtained increased production per unit area of land but we also got trapped into clearing, planting, weeding, harvesting, winnowing, pounding, roasting, grinding and so on, together with all the additional tools involved.

Domesticated plants thus came to depend on humans for their propagation, but they retained a role in how that propagation occurred. Their biology and ecology drew people in in a particular way. For example, Fuller (2007: 911) discusses the evidence from the Middle East that wheat took longer to domesticate – perhaps 2000 years, in comparison to barley – perhaps 1500 years. Some of the contributing factors include ecological factors – such as the fact that slightly higher average rates of cross-pollination are reported for barley. Another factor may be that barley 'is more prone to be a weed of cultivation, thereby maintaining introgression, whereas wheat cultivation, which is more water-demanding and may have been more carefully located, would have been cut off from the wild progenitor' (Fuller 2007: 911).

Thus many plants have come to depend on humans for their reproduction and survival. But this is more than a mutualism and co-evolution between plants and humans since the reproduction and processing of the plants put a double burden on humans. Humans both depended on plants and got drawn into elaborate procedures that maintained propagation and edibility. It is necessary to explore the behavioral and biological properties of plants in order to understand the ways in which humans got drawn in. The same arguments can be made in relation to animal biology and Behavioral Ecology. It is clear that the use by hunter-gatherers and farmers of wild and domestic animals was and is closely tied to the behavioral possibilities and potentials of the animals.

An underlying assumption of Behavioral Ecology 'is that an animal's reproductive cycle, group size, density and composition, and movements are adaptations to the available food and water resources, predators and commensals, and the requirements and tolerances of the animal itself' (Martin 2000: 15). By exploring animal behavior in this way, archaeologists are able to understand the ways in which human exploitation of the animals gets drawn in. For example, Louise Martin (2000) obtained data from 18 modern populations of the genus *Gazella*, in order to explore the factors that influence behavior. Such data allowed her to suggest how gazelle would have behaved in particular environments and under particular constraints in the past. She was mainly interested in applying this to the

period from 20 000 to 7500 BC in the southern Levant when sites commonly have large frequencies of gazelle bones. In fact during early sedentism in the southern Levant (that is from 12 500 BC to 8500 cal BC in Natufian, PPNA and early PPNB contexts) it was gazelle that was mainly exploited (Horwitz *et al.* 1999, Clutton-Brock 1981). But humans never managed to domesticate gazelle sufficiently to control reproduction and cause genetic change. Garrard (1984: 125) notes that the mature males of the types of gazelle and deer common in the region are individually territorial for part of the year. The dominant males attempt to isolate oestrous females from fellow male competitors. To keep such animals in concentrated herds at the time of the rut will lead to social stress and a decrease in body condition. Deer and gazelle are also extremely agile which means that very high fences are required to pen them. They are adapted to escape from fast predators (Clutton-Brock 1981). They are nervous and can run very fast – when constrained by high fences they can panic. It is much easier to keep sheep, goat, cattle and pig in captivity than deer or gazelle. The latter 'are not easy to manage, they are territorial in their behavior and much less flexible in their feeding habits than goats and sheep, also they will not breed easily if kept in close confinement' (Clutton-Brock 1981: 50).

Horwitz *et al.* (1999) make a similar point regarding goats. They note an increase in wild goat in sites in southern Levant in middle PPNB. But they suggest that sheep were probably the first domesticated animals in late PPNB in the southern Levant, probably introduced from the north (Vigne 2008). They argue that the attempts to domesticate the goat in the middle PPNB in the southern Levant failed for ethological reasons. For sheep 'with some very simple techniques, it is possible to link a herd of animals to individuals within a human group. Ethological data seems to indicate that *Capra*, which was domesticated later, is a more independent animal' (Horwitz *et al.* 1999: 67).

The behavior of sheep and to some degree goats is often described as being well adapted to associate with humans as they became more sedentary. *Ovis orientalis*, the Asiatic mouflon, was probably the ancestor of all domestic sheep and like other Eurasian wild sheep had a 'submissive posture' that enabled personal relationships to develop between an animal and man (Clutton-Brock 1981: 55). Deer and gazelle are territorial animals that live in groups but they do not have a social structure based on dominance hierarchies (Kaya *et al.* 2004, Schaller 1977). 'Man, sheep, and goats, on the other hand, have a social system that is based on a single dominant leader' (Clutton-Brock 1981: 55) and they have a home range but do not defend a territory. They flourish well when crowded together. Ewes form close bonds with their offspring and this encourages following behavior, with an older and more independent animal towards the front. Smaller groups of males are segregated from the female flock but share an overlapping home range. Sheep are not as nervous as deer and gazelle, cannot run so fast, and they can be trained to stay close to a human settlement as their own home ranges are relatively localized.

The characteristics of animals that would have led to closer relationships with humans as they became increasingly sedentary included palatability, high yield, a reasonable number of offspring a year, limited agility, a wide environmental and dietary tolerance (Garrard 1984). Also important were that the species live in large herds, organized along hierarchical lines and including both sexes. Best are those species with minimal fighting so that there is little social stress when confined. The foursome of sheep, goat, pig and cattle to varying degrees fulfill these requirements in contrast to deer and gazelle. In addition, there is an ecological compatibility between the four. Cattle and sheep can be kept on the same pasture, cattle eating the tips of the grass and sheep the bases. Goats are browsers and pigs general omnivores (Garrard 1984). But all these animals begin to transform as they become more closely associated with humans. Sheep, for example, begin to decrease in size as they are increasingly penned and placed within an anthropogenic environment. Ewes have access to poorer graze and their offspring are smaller; or larger ewes under stress might not be able to come into oestrus – so a perhaps unintentional result of closer management is a decrease in size. In the wild, sheep and goat are skittish, darting and stopping, but once kept and managed they become more docile, perhaps because of the selective culling of young males and a resulting decrease in competition between them. The decrease in competition between males may also lead to males being smaller. In all these ways sheep and goats (as well as cattle and pigs) became increasingly dependent on humans for their care and reproduction.

This dependence of sheep (and the other domesticable animals) on humans trapped humans into greater investment, care, regulation and discipline. Zeder and Hesse (2000) argue that early pre-domestication human practices involved selective killing of younger male goats in the western highlands of Iran at Ganj-Dareh and Ali Kosh at 8000 cal BC. This may have been a conservation measure to safeguard females and their reproductive potential. But by killing off young males in sheep and goat flocks, humans were changing the genetic make-up of the flock and the selection and management of stud males would have become of importance – forcing cooperation and organization amongst humans. As soon as humans started investing in sheep and goats they needed to protect that investment – caring for the females, selecting and caring for stud males. The investment involved protecting sheep from wolves. But the sheep needed to be kept in groups or flocks of a certain size (perhaps 50 – Louise Martin pers comm.) in order to maintain genetic diversity. But households were small. Again cooperation between humans was forced. Wild sheep have home ranges that gradually shift in relation to resources. But as they are corralled and managed so feed has to be provided or humans and perhaps their dogs have to travel with them as herders over increasingly wide distances.

Right from the start of husbanding and then domesticating animals, humans got drawn into their care. In recent arguments, Vigne (2008, Tresset and Vigne 2007) has pointed to evidence that early domestication of animals may not have

been primarily in order to obtain more meat. One of the reasons for early domestication of animals may have been milk, and domestic animals may also have been used to provide dung in agriculture, building and heating, and to provide load-bearing and draft power capabilities (mainly in relation to cattle). Within such a scenario, large amounts of human labor would have become tied up in milking and processing milk and its by-products. There is all the organizational effort in herding animals in relation to arable fields at different times of the year, and all the labor in collecting dung and drying it for fuel. There is all the investment in training animals and providing equipment so that they can carry or pull loads.

These labor investments increased through time. Halstead (1996) argues that mixed farming characterized much of Greek prehistory, but that as shifts to more specialized pastoral economies occurred there were larger herds, grazing had to be scheduled to enhance nutrition and productivity, and there was specialization in particular products for exchange. Complex strategies had to be followed to make sure that sheep, especially pregnant ewes and young animals at particular times of the year got sufficient nutrition – through providing specific grazing for them or fodder. Looking after animals became increasingly labor intensive.

Humans depend on animals as they increasingly husband and domesticate and breed them. But it can also be argued that animals depend on humans to propagate them. In some views, domesticates are seen as manipulating humans for their own evolutionary advantage, using humans to ensure their widespread dispersal (Rindos 1984). Certainly it is possible to argue that both partners in the relationship derive benefit from the other (Zeder 2006). Plants and animals have increased reproductive fitness and their range expands. Humans gain higher productivity per unit of land, greater security and predictability in their access to resources. Thus Zeder *et al.* (2006: 139) state that 'domestication is a unique form of mutualism that develops between a human population and a target plant or animal population, and has strong selective advantages for both partners … It is a cumulative process marked by changes on both sides of the mutualistic relationship, as both partner populations, over time, become increasingly interdependent.'

Zeder (2006) argues that domestication does differ from other forms of mutualism amongst plants and animals in that humans have intentionality so everything happens more quickly and with more interference. In the terms argued in this book, the forms of dependence that emerged between humans, plants and animals involved both human dependence and dependency. There was more than just mutual reliance (dependence). There was also an ensnaring and entrapment (dependency) as humans tried to maintain plants and animals as they wanted them. Plants and animals could be said to have invested in the domestication relationship with humans in that they underwent genetic change, and became isolated from populations not involved in the relationship. Humans became involved in such a way that they had to work harder, becoming constrained by the dependency. Humans found themselves involved in tilling, watering, burning, clearing land, sowing, and transplanting plants, or in taming, protecting, herding, culling,

and selectively breeding animals (Zeder 2006). In addition there were all the issues of property raised by the investments in land, plants and animals. There were all the tools, the social relationships, the houses and buildings and walls that allowed the animals and plants to be kept, stored, guarded, exchanged, maintained. Humans had become multiply bound – by the nutrition gained from the plants and animals, but also by tending to the behavior of the plants and animals and by managing all their connections and interactions.

Human Behavioral Ecology

In relation to animal and plant behavior there is of course a vast range of literature in Behavioral and Evolutionary Ecology that can be used as a basis for understanding the ways in which humans wishing to gather and cultivate plants or wishing to hunt and domesticate animals would have been drawn into certain types of behavior. We have looked above at how the Behavioral Ecology of plants and animals helps archaeologists to understand how humans are drawn into their care as they become dependent on humans. Human Behavioral Ecology on the other hand directs its attention to human behavior (especially of hunter-gatherers) itself and how it makes use of resources differently in different conditions. The approach explores the processes and interactions of humans and things. Like Behavioral Ecology more generally it makes optimization assumptions, and assumes a larger Evolutionary Ecology framework.

Human Behavioral Ecology (HBE) is having increasing influence in archaeology (Winterhalder and Smith 2000, Winterhalder and Kennett 2006). Winterhalder and Smith argue that HBE is largely concerned with how humans behave in specific ecological conditions. Hypotheses deal with 'the potential fitness-related trade-offs individuals may face in particular socio-ecological contexts' (Bird and O'Connell, 2006: 146). Behavioral diversity is seen as largely the result of variability of context. Unlike the evolutionary models to be considered in Chapter 6, there is little focus on historical determinants. Behavioral costs and benefits are evaluated in universal terms, but adjusted to specific contexts.

Some of the most popular models (Bettinger 2009), often quantitative, that have been used in HBE include the diet breadth or prey-choice models influenced by Optimal Foraging Theory in which it is assumed that maximizing the rate of nutrient acquisition enhances fitness (Bird and O'Connell 2006: 146). Fitness can be defined not just in terms of number of offspring but in terms of a multitude of factors including survivorship of self or offspring. In the diet-breadth studies the aim is to model how humans balance different parts of complex decision-making – such as evaluating the costs and benefits of searching for game against the costs and benefits of handling and processing the game after an encounter and kill. In other words, is it in my interests to kill and handle game that I come across or

should I wait until I have a better opportunity? The answer is seen as depending on the abundance, and thus the encounter rate with the highest ranking prey, where rank is determined in terms of relative return. Encounter rates are also related to the 'patchiness' of the prey.

It is assumed that humans will exploit those resources which have the highest rate of return – and that humans will go down the ladder to lower rates when pressures on resources increase (Bird and O'Connell 2006). Depending on the model, the rate of return could include the costs of collecting, processing and making tools, and in terms of sustainable exploitation the rate of return can include conservation measures. HBE studies include those that explore resource acquisition decisions that are conservationist – defined as 'any resource use restraint that sacrifices short-term yield and fitness gains in order to realize long-term benefits from heightened sustainability or yield' (Winterhalder and Smith 2000: 56). Thus diet-breadth models can be construed as including descriptions of the ways in which the behavior of resources (that is their depletion or conservation) depend on further action by humans. For example, Bird *et al.* (2005, Bliege Bird *et al.* 2008) have documented the complex interactions between Australian Aboriginal burning of landscapes and the availability of different types of game suggesting that while anthropogenic fire is used for immediate gains in hunting, the resulting mosaics can be beneficial to other plants and animals. The outcomes may also vary depending on factors like gender: in a study of fishing among Torres Strait Islanders, Rebecca Bliege Bird (2007) has documented the complex interplay between the behavior of different types of fish and the behavior of men and women as they obtain resources and incorporate risk differently into their strategies.

One diachronic expectation from diet-breadth models is a gradual shift from high ranked resources to lower-ranked resources if humans negatively impact the highest ranking resources. For example, in northern California and in the Middle East, 'harvests of highly ranked species (e.g. sturgeon, elk, white-tailed deer) drop steadily relative to low-ranked species (e.g. shellfish, acorns, small mammals)' (Winterhalder and Smith 2000: 58). This shift to a broad spectrum economy in the Middle East heralds the intensive exploitation of plants leading to agriculture. In more general terms HBE work has shown that this shift often involves a shift to prey with high handling costs relative to energetic yield, and a shift to using more distant and thus costlier patches. However, Codding *et al.* (2010) have argued that declines in the abundance of highly ranked prey can also occur as a function of stochastic environmental events (such as droughts) and as a function of differences in the social costs and benefits of hunting (not just food benefits).

An example from Çatalhöyük helps to indicate the value of such an approach, especially if expanded to consider more than relative returns in terms of nutrition acquisition. During the course of the 7th millennium BC sequence at the site, the faunal assemblage shows a decline in the frequencies of wild cattle such that by the end of the sequence the frequencies of domestic sheep and goat attain an increased dominance. This shift may be explainable in terms of movement to lower ranked

nutritional resources with higher handling costs (all the costs of herding and maintaining domestic sheep). But the contextual evidence from the site also suggests that this shift is towards a lower ranked resource in social terms. Wild cattle had high social value at the site as seen in their depiction in wall paintings, in the large numbers of cattle horn figurines and in the installation of cattle horns and skulls in houses. Domestic sheep and goat had lower rank in social terms as is seen in the fact that they do not occur in the art and symbolism. The value of a HBE approach in this context is that it draws attention to the handling costs and energetic returns from these animals. That there were increased handling costs and lower energetic returns for sheep and goat is evident from all the evidence of intensive processing of sheep and goat. The bones of these animals were broken up into small pieces and intensively processed, probably by boiling in pots, in order to extract fats and marrows. Wild cattle bones were less thoroughly processed. They were often consumed in feasting. It is possible to argue that as wild cattle were hunted and depleted it was necessary to turn to lower ranked resources (sheep) and the more intensive processing that made their exploitation worthwhile. And it may indeed be the case that use of wild cattle for subsistence, feasting, displays of prowess and social competition led to their depletion in the landscape and so a switch to lower ranked resources. But the complex decision-making certainly involved more than nutrition and handling costs; it also involved the social prestige of the animals. Losing the social prestige gained from killing and feasting on wild cattle was certainly part of the trade-offs that had to be taken into account. The decline in wild cattle in faunal assemblages and installations at Çatalhöyük occurs at the same time as gradual shifts in burial practice, more frequent rebuilding of houses, less exact replication of houses, larger houses more focused on domestic production and storage and so on (Düring 2006, Hodder 2006b). Given all these other changes going on, it would have been 'cost-effective' (including social costs) to shift to a greater focus on domestic sheep and goat. The types of question asked by HBE allow some of the links of the chains to be explored; but they could be extended to a wider consideration of all the trade-offs involved.

Cost and benefit decision-making can also be considered in relation to technologies. There has been consideration of the trade-offs involved in different types of manufacture, maintenance and repair of stone tools (Bird and O'Connell 2006: 152). For example, Elston and Brantingham (2002) look at the costs and benefits of using microliths in making projectile points rather than using simple stone or wooden points. The microliths are set into shafts made of bone or wood. They find that the microlithic multi-component projectiles are more expensive to make but they are less likely to fail and they are easier to repair – so they will be preferred in certain climatic and demographic contexts. Such work is of value in exploring how the falling apart of things can be taken into account in understanding the decision-making that leads to new technologies. The projectile point depends on humans to be maintained – and HBE helps define the factors involved in making the decisions about whether to maintain a thing or not. But again, such decisions

are unlikely to be just about climate and demography – there is so much else involved in all the thing-thing, human-thing connections surrounding projectile points, such as distance to the source of lithic material (Beck *et al.* 2002), friability and workability of the material, exchange relations, availability of technological expertise, prestige of elaborate points (Belfer-Cohen and Goring-Morris 2002).

HBE 'takes into account the costs of making and maintaining gear, the returns gained as a result, and the time period over which the technology is to be deployed' (Bird and O'Connell 2006: 153, see also Bettinger 2009). It offers a systematic way of exploring the trade-offs, the complex decision-making that lie behind technological choices. Bird and O'Connell (2006) suggest that increased investment in handling or processing technologies can be read as evidence for greater diet breadth. If humans are investing in expensive food processing activities such as making and using pots, the adoption of low-ranked, hard-to-handle resources is implied. High investments in processing imply a low nutrient return ratio. Again we can explore this idea at Çatalhöyük where cooking pottery was introduced in Level VII. The pots seem mainly to have been used in the intensive processing of sheep and goat meat, bones and fat. So the evidence fits the model that the investment in a labor intensive processing technique – making pots to process food and fats – is associated with a low-ranked resource. But again, there were many other things going on at this time at Çatalhöyük. The introduction of cooking pottery involved a shift from organic to mineral tempered wares in Level VII. This shift may itself have been made economically viable by a shift at the same time to a new type of sandier brick for house construction. The coincidence of these two sets of changes suggests that as people dug deeper to get sandier clays for mudbricks, they also collected sandier clays for pots. As we have seen, the shift to sandier bricks probably involved more complex schedules and labor organization. This change in brick organization may itself have been linked to the more specialized production of thinner walled pots for cooking. There are other links such as the increased use of dung fuel to fire pots. ALL these interlinked factors are part of the trade-offs in decision-making (comparable to the 'opportunity costs' as defined in HBE – Winterhalder 1998: 47). It is not adequate to focus just on the immediate nutrient return in relation to the effort involved in the processing of sheep and goat meat, bone and fat. There is much more involved down the chains of dependences.

The reductionism of HBE can be seen as one of its virtues – because reducing a problem to its key elements is an element of good science (Bird and O'Connell 2006). We have seen by contrast that all humans and things are dependent on other humans and things in complex webs. HBE is of value in exploring how things and humans work practically in relation to each other along these chains. The focus on the practical issues of nutrient extraction and maintenance costs is an important component in the study of human-thing dependences. It draws stark attention to the fact that increased dependences between humans and things often involve quantifiable decreases in the return for each unit of energy expenditure even if they increase productivity overall or per unit of land. But it cannot be adequate to

stop the consideration of factors, choices and trade-offs at some arbitrary point along the chains in the networks. We need to take all the research described in Chapter 2 seriously; humans depend on things for more than nutrition and these complex dependences play a part in decision-making.

Focus on the complexity of behavioral adaptations should allow a retreat from optimization models that are based on maximizing nutrient acquisition and minimizing costs of tools and handling. As the full complexities of links along chains of interaction are absorbed into behavioral models, it becomes clear that more general measures can be defined. The minimizing of costs comes to be seen in relation not to a universal standard of time and energy expenditure but in terms of, for example, minimizing disruption to other parts of the system. The maximizing of benefits can be defined not in terms of universal measures of nutrient input but in terms of benefits to linked parts of the system or network. In these ways the focus on enhancing 'fitness' becomes transformed into an examination of increased 'fittingness' as will be described in Chapter 6.

The Temporalities of Things

An impetus that led to this book was the work by Woodburn (e.g. 1980, 1998) on delayed return subsistence systems. He distinguished different types of hunter-gatherer society. Those with immediate return systems shared the meat from animals soon after the kill. They invested little in equipment and as a result had little role for long-term social structures and institutions. In delayed return systems, on the other hand, humans invested in joint labor such as the making of boats or nets or the clearance of land that produced returns over the long term. Farmers too have delayed return systems as they dig land and harvest crops. Longer term social institutions are needed to hold the group together between the investment of labor and its return.

At the heart of this distinction between immediate and delayed return systems are the temporalities of humans and things. Humans invest labor, expend energy and in small-scale hunter-gatherer societies expect a quick return. But if they plant a cereal, or tend it in its wild state, they have to wait for the crop to be harvested before they get a return. If they build a boat it takes time and a lot of energy and skill – too much to repeat every time they go fishing. So they have invested in the boat which has its own temporality – the boat lasts so it can be reused. Humans are thus drawn in to the different temporalities of things.

Humans get caught up in the rhythms of the plants, their growing and maturing seasons and in the life-cycles of animals. But they also get caught in the time it takes for clay to dry, the time it takes for marl plaster to start to deteriorate, the time it takes for metal to heat and be hammered, etc. We have to 'wait for' the crops to grow and ripen, we have to 'wait for' the winter to pass and the spring

growth to start. Or we try to 'put off' the time when the house has to be renewed, or schedule our lives so that we can go and make bricks and make pottery. In complex industrial societies 'human actors have to "retreat" while machines process and produce some material results' (Preda 1999: 353). The machines produce information that has to be interpreted and made sense of. So humans get caught up in a temporal structure that is partly produced by the machines. Rather as in Mauss' gift exchange, the machines produce delays and intervals. In the process of postponement people get caught up. They have to construct societies in which humans live their lives to the pace of things.

In relation to human life-cycles there is an uncertainty and unpredictability to the life-cycles of things. Things have lives of their own that intersect with humans at specific points. As a wall stands over decades, centuries, millennia, it gradually erodes. This may not matter for many life-cycles of humans. But ultimately a point will come when the erosion of the wall impedes the functioning of the wall, whatever that may be. In rainy climates, walls often erode quickest at the bottom where rain spatters against the mud or stone. A wall enclosing a property may stand well for hundreds of years, but suddenly the wall may falter as the mudbrick or sandstone at its base dissolves. It is difficult to predict when this will happen. But for most walls some sort of collapse will happen at some point, requiring attention and care. At this unpredictable point the life-cycles of humans and things intersect. Humans are drawn in to invest further labor in the thing.

In the discussion of operational and behavioral chains in Chapter 3, I described how things have to occur in order. Productive sequences go through the order of procurement, manufacture, exchange, use and discard. A particular step in the process must wait for other things to happen in sequence and at the right time; so there is constraint and dependency in the scheduling. Decisions made at one point in the productive process have down-stream effects on later decisions and uses of a thing. Understanding the temporal cycles of plants, animals and things is key to understanding how humans are drawn in to their biographies. There is a certain predictability to growth cycles of plants and animals though even these can be hit by unforeseen larger scale climatic events. There is much less predictability to the durability of material objects. We know they may last for a time but there is an unruliness to the interactions between things so that it is difficult to predict when the wall will crumble, when maintenance and rebuilding will be required.

Conclusion: The Unruliness of Things

The aim of this chapter has been to extend the rather obvious point that things depend on people by focusing on the idea that the behavior of things, plants and animals traps humans into various forms of care. Things depend on people when they are procured, manufactured, exchanged, used and discarded but in particular

they depend on people to maintain them if they are to remain as people want them. Or they depend on humans to maintain the environments in which they thrive. Made things are not inert or isolated. Their connections with other things and their maintenance depend on humans. So the main conclusion of this chapter is that this dependence of things on humans draws humans deeper into the orbit of things. Looking after things as they get depleted or fall apart or as they grow and reproduce traps humans into harder labor, greater social debts and duties, changed schedules and temporalities. This is true of plants and animals whose lives have been changed by humans, but it is also true of all things that involve some form of human investment.

It might be argued that humans, ever since the first shift to a broad spectrum economy in the late Pleistocene have been on a long-term program of increasing diet breadth as they adopted yet new forms of energy and nutrient capture that required yet more intensive processing, conservation and management. As they have increasingly 'domesticated' clay, metal, oil, nuclear particles, water, and so on, these diverse things have increasingly depended on humans for their care and maintenance. Humans have had increasingly to invest labor and new technologies to manage and sustain these things and have found themselves organized by them. The challenge posed by things, as in the current debate over global climate change, becomes ever larger and more intractable.

Indeed it could further be argued that humans become regulated and disciplined in their interactions with things in all their complexities and falling-apart uncertainties. The Department of Transport and its catalogues of rules and regulations are necessary to make sure we do not kill each other as we drive cars. To make sure we do not lose or mis-direct money we need banks; to manage our failing bodies we need hospitals; to look after decaying sites we need UNESCO; to deal with disputes about property we need lawyers and courts of justice; to prevent people steeling things and killing each other over things we need prisons. It is as if we cannot quite manage with things. They get us into difficulty – so we find ourselves regulated and disciplined. We go towards things, we need them and want them but we have to be kept away from them also. Things and humans become fickle and unruly in relation to each other. The different temporalities of humans and things create uncertainty and the need for vigilance and discipline. Far from society being based solely on the stability of things, it seems that human-thing relationships create instability that needs to be stabilized.

In the above paragraph it is apparent that it is not just the falling apart of things that that produces unruliness and the need for regulation. As we saw in Chapter 2 and will see throughout this book, things unleash potential in humans. This potential includes human conflict over the ownership and control of things. Put yet more generally, humans have the capacity to always think differently about things, including whether things should be alienable or inalienable, made or owned by the community or by the individual, exchanged or horded, preserved or destroyed. There is always the potential for contestation and conflict about things and the

labels and tags we give them. Because humans have limitless potential in their relationships with things, there is the potential for unruliness and the need for regulation.

The unruliness of things derives from the fact that they are not inert and not isolated, but it is exacerbated by the fact that humans and things live in different temporalities. The unruliness derives also from the complexity of human-thing dependences so that it is very difficult to monitor all the possible interactions and conjunctions. The multivariate connections multiply possible outcomes and make predictions difficult. But also humans become unruly in their relationships to things, contesting and challenging rights and duties. For all these reasons, things and human-thing interactions are often surrounded by regulation and systems of management and care.

In this chapter I have focused on approaches that explore the behavior of materials, plants and animals. When these different things come to depend on humans for their continued existence in the way that humans want them, humans too get drawn into their specific behaviors and temporalities. Humans get trapped looking after wheats that will not reproduce without them; they get trapped by walls that will not stay up without them; they get caught up in the lives of sheep. In the next chapter I will elaborate on this notion of getting 'caught up' in things within a theory of entanglement.

Chapter 5
Entanglement

The plane is waiting on the tarmac while its metal fatigue is examined. For several hours I am stuck inside, thinking and fuming – thinking about the huge discourses of health and safety, rules of procedure, massive bureaucracies all dealing with keeping planes flying safely and all of which mean that none of the passengers can get out of the plane until security procedures have been put in place, luggage retrieved, an available gate found. For the moment I am stuck inside the plane – I cannot get out.

The previous three chapters have examined how humans depend on things (HT), how things depend on other things (TT), how things depend on humans (TH). If we add the obvious point that humans depend on humans (HH), then entanglement, at one level, is simply the addition of these four sets of dependences and dependencies.

$$\text{Entanglement} = (\text{HT}) + (\text{TT}) + (\text{TH}) + (\text{HH})$$

The defining aspect of entanglement with things is that humans get caught in a double bind, depending on things that depend on humans. Put another way, things as we want them have limited ability to reproduce themselves, so in our dependence on them we become entrapped in their dependence on us. Already in Chapter 4 I described how thing dependence on humans entraps humans into investment and care. But this is only because humans are so utterly dependent on things in the first place (Chapter 2), and it is amplified because things depend on other things (Chapter 3).

There is thus a dialectic relationship between dependence, often productive and enabling, and dependency, often constraining and limiting. Humans and things, humans and humans, things and things depend on each other, they rely on each other, produce each other. But that dependence is in continual tension with

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boundaries and constraints as things and humans reach various limits (of resources, of material and social possibility) that are overcome by, that demand, yet further dependence and investment. Entanglement can thus be defined as the dialectic of dependence and dependency.

Most studies of the social realm concentrate on the relationships between humans, in relations of exchange, power, representation and so on. Things are certainly involved but as mediators or tools, actively involved in social tensions and resolutions. Rather than this human-centered view, I have claimed that things exist in a world that is to some degree their own. Things have lives, vibrant lives (Bennett 2010) and temporalities, and they depend on each other and on humans. This separate world of things draws humans in. The social world of humans and the material world of things are entangled together by dependences and dependencies that create potentials, further investments and entrapments.

I wish in this chapter to differentiate my use of the term entanglement from other related terms and uses of the word, and also to explore some aspects and forms of entanglement.

Other Approaches

Many scholars have described the complex networks, mixes, engagements that result from the dependence of humans on things, things on things, and things on humans. For example, there are the actor networks or heterogeneous mixes of humans and things as defined by Latour and his colleagues that I will discuss below (Latour 2005). There is Renfrew's (2004) material engagement between humans and things discussed in Chapter 2 or Heidegger's (1973: 97) 'equipmental totality'. As we saw in Chapter 3, French technological studies have long focused on the *chaînes opératoires* through which things and humans pass as artifacts are produced (Leroi-Gourhan 1964–65, Lemonnier 1993a) and the behavioral chains from procurement to discard have been described by Schiffer (1999). There is also the mutualism and symbiosis between humans, plants and the environment discussed in Chapter 4 and so well described by Darwin (1859) at the end of the Origin of Species and often used as a source for ideas on co-evolution and symbiosis: 'It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about'.

Mauss (1954, 25–26) wrote that 'souls are mixed with things; things with souls' and in this anthropological tradition others such as Marilyn Strathern (1988) have talked of enchainment or distributed personhood (as discussed in Chapter 2). The term 'enchainment' as used by Strathern refers to Polynesian and Melanesian cultures where an artifact is not 'a thing-in-itself'. It does not acquire identity from those who use it nor give identity to people. A thing is part of a chain of obligations and desires as things circulate, passed around as gifts. 'If in a commodity economy

things and persons assume the social form of things, then in a gift economy they assume the social form of persons' (Strathern 1988: 103). In this context persons are 'dividuals' or 'partible persons' – that is persons are the products of chains of socially reproductive acts, so there is no division between the social and individual persona. So every person is a product of others, or has an identity which is produced from all the social actions that were involved in marriage, giving birth, nurturing, etc. Enchainment is created because of the 'hau' of things – that is their need to be moved on, to be mobile. Gifts are treated as responsibilities that are to be quickly got rid of – it is wrong, impossible for something to be stationary. Others such as Munn (1986) and Weiner (1992) have described similar processes.

The complex inter-connections between people resulting from the exchange of things is also seen in post-colonial studies, as in Nick Thomas' (1991) book on 'entangled objects'. He writes of western and non-western peoples 'mutually entangled in an array of rights and obligations, people who are "reciprocally dependent"' (Thomas 1991: 14) in the exchange of objects in the processes of colonialism. 'The notion of entanglement aims to capture the dialectic of international inequalities and local appropriations' (Thomas 1991: 207). Rather than opposing European and indigenous, global and local, capitalist commodity and reciprocal gift, domination and resistance, Thomas and others working on colonial interactions (e.g. Dietler 1998, 2010, Gosden 2004, Jordan 2009b, Orser 1996, Silliman 2005, Stein 2005) build on notions of creolization and hybridity to attain 'a more historically accurate consideration of the complexities of the colonial encounter' (Martindale 2009: 61). In her work on contemporary South Africa, Nuttall (2009) describes the historical entanglements between blacks and whites. The more whites dispossessed blacks, the more whites depended on blacks (for labor) and the more blacks depended on whites. In their dependence on blacks whites erected an ideology of separation and difference – racism. In effect Nuttall describes a co-dependency. She problematizes simple oppositions between colonizer and colonized, metropole and colony, center and periphery, domination and resistance. She talks instead of an entanglement or 'web, carrying with it the notion of interlacing, an intricacy of pattern or circumstance, a membrane that connects' (Nuttall 2009: 3).

Archaeologists have often focused on how things create links between people (e.g. Chapman 2000, Gamble 2004). But the relationships between humans and things in the formula above are not interactions but dependences. The two forms of dependence and dependency were described in Chapter 2. The anthropological work on exchange and post-colonialism is alive to both these aspects of dependence. What they often lack, on the other hand, as was discussed in Chapter 2, is an adequate engagement with the object nature of things. The focus is on relationships between people, how things connect opposed categories and allow for hybridity and transformation. There is a lack of symmetry in the treatment of things. Strathern eschews the thing-in-itself.

But as we saw in Chapters 3 and 4, things themselves need each other and they need us. So when we use them we are drawn into their objectness and into the care of their unruly behavior. Cultural anthropologists are often wary of talking of the

'costs' of things and of the maintenance and care of things since 'cost' seems to imply some universal measure. But as we saw in Chapter 4, costs do not need to be defined only in terms of universal measures, maximum returns on some universal standard. Rather, costs can be defined in terms of the different types of investment made in things by humans from all parts of the tangled system and in terms of the disruption of all types caused to other parts of the entanglement. In other words, the evaluation of costs and benefits is a study of the flows of matter, energy and information through things. Least cost and maximum benefit can be defined in terms of the overall and specific flows.

Latour and Actor Network Theory

Latour and others in sociology of science studies do take material things in themselves seriously and they seek a more balanced or integrated analysis of humans and things. Sociologists have tended to see the social world as about interpersonal relations. But Latour (1990, 1993), Law (1999) and Knorr-Cetina (1981) have come to see how engines, measuring instruments, laboratory probes, detectors play a part as actors in structuring social relationships. These authors explore the production of scientific knowledge in the laboratory, but they also argue that similar social/thing processes occur more widely. They focus on the actor networks of big things like the computerized rail transportation system called ARAMIS (Latour 1996), but they also look at small things like pipettes, paper blueprints, computer screens and so on. Given this greater focus on material things than we saw in the various approaches discussed in Chapter 2 (material culture studies), it is not surprising that there is an increasing influence in archaeology (Olsen 2007, Shanks 2007, Webmoor 2007, Witmore 2007, Webmoor and Witmore 2008).

The aim of this type of approach, often termed Actor Network Theory (ANT), is to focus on relationality rather than on apparent fixed and essential dualisms such as truth and falsehood, agency and structure, human and non-human, before and after, knowledge and power, context and content, materiality and sociality, activity and passivity. It is not that there are no such divisions but that the distinctions are effects or outcomes. 'They are not given in the order of things' (Law 1999: 3). Thus ANT conducts a 'semiotics of materiality'. It takes the semiotic focus on relationality and applies it to all materials, producing a relational materiality (Joyce 2002).

As an initial example we can take Latour's (1988) study of the 'pasteurization of France' in which the microbe comes to be seen as an 'essential actor' (Latour 1988: 39). Microbes as things connect people and they connect people and things. Those in our guts connect us to what we eat. They also connect us through the spread of contagious diseases and because we depend on each other to be hygienic and defeat microbes (Latour 1988: 37). So there is a clear focus on dependence here. We depend on the microbes that pasteurize beer in order to have economic relations between brewers and customers. We depend on sterilizing milk in order to

be able to feed our children milk products. At the end of the 19th and early 20th centuries, the triumph of hygiene allowed the First World War to be conducted since 'without the bacteriologists, the generals would never have been able to hold on to millions of men for four years in muddy, rat-infested trenches' (Latour 1988: 112). The dependence has costs – the costs of 'setting up new professions, institutions, laboratories, and skills at all points' (Latour 1988: 39).

In this case Latour describes the actors as heterogeneous, made up of linked entities such as hygienists, drains, Agar gels, chickens, farms, insects of all kinds. The actors are human, non-human, individual entities and large institutions. The aim is to avoid reductionism and to focus on the dispersed networks through which such actors come to have form and come to act (cf. Latour 1993). In another example, Law and Mol (2008) look at how sheep in Cumbria were caught during a foot and mouth epidemic in a network of vets, laboratories, theories about epidemiology and disease spread, economic considerations about loss of economic wealth from slaughter of sheep, farmers' knowledge about flocks and their grazing patterns, slaughter houses, etc. In this view, action moves around like a viscous fluid – what any actor does depends on other actors; and yet each actor has its own stubborn specificity. 'So much comes together in the collaborative webs of complex practices' (Law and Mol: 73). The landscape depends on the sheep in order for it to be maintained in its present form but the Common Agricultural Policy encouraged farmers to put too many sheep on the landscape. So 'the landscape depends on the sheep – but if there are too many of them, it gets destroyed. Activities have complex and often unpredictable effects. And the interfering webs that make up assemblages lead to surprises, too. All of which means that what emerges is hard to predict. For assemblages, like actors, are creative. They have novel effects and they make new things' (Law and Mol: 74).

In such work there is an interest in what happens when things don't work and go wrong, as discussed in Chapter 4. Knorr-Cetina (1981) discusses a broken laboratory instrument and the effects this had. The scientists started to use a centrifuge in place of the broken instrument. By tinkering with the centrifuge, the measurement process came to be redefined, leading to a reworking of the scientists' problem. The humans, their research and the instruments were thoroughly entangled in each other. The network required continuous 'social, technical, *and* financial maintenance, surveillance, and repairs' (Preda 1999: 363). There is a 'practical codependency between knowledge embodied by the researchers and knowledge incorporated in the instruments' (Preda 1999: 352). Latour talks of this co-dependence as 'a work of hybridization' (1993: 11).

Given this strain in ANT of incorporating dependence and dependency into analyses and interpretations of human-thing interactions, the use of the term 'network' might seem inadequate. Latour (1999, see also 2005) argues that indeed the idea of network has lost its critical valency because of the emphasis on information exchange and networks of global interaction in the World Wide Web. He suggests that in ANT 'network' originally meant transformations and translations.

It referred to the complexities of linkages that made things related beyond their supposed existence as stable regional entities. In Spanish 'network' is translated as 'red' and in French as 'réseau' both of which have the connotations of web or mesh. Ingold (2010) suggests that such terms give a better sense of rhizomic flows than does the term network (see also Latour 2005). The spider's web is an extension of the spider and makes possible the life of the spider. Ingold prefers the word meshwork to give a better sense of flows of force and lived gatherings, rather than objects connected by networks.

And yet there remains a tendency for ANT to give insufficient attention to the ways in which humans and things in their physical connectedness to each other (Chapters 3 and 4) entrap each other. Latour's focus is often on the mixing of humans and nonhumans and he rejects culture/nature oppositions. Indeed the whole of ANT is built upon a move away from fixed essentialist dualisms such as materiality and sociality, human and nonhuman. In my view this goes too far. When the ice melted at the end of the Pleistocene it had a widespread affect on human society. There was some relationship with the emergence of settled villages and domestication of plants and animals. Even if this effect was varied in different parts of the globe, and even if we do not understand the effects adequately, this climate change, unlike our own, was independent of humans.

Pierre Lemonnier took Bruno Latour's symmetrical approach to task for its tendency to overlook material constraints and focus on sociological issues. In his response (Lemonnier and Latour 1996) Latour agreed that pure, asocial material constraints did not exist in his perspective. Because Latour is intent on moving beyond subject/object dualisms and dialectical relations, he often appears to show little interest in objects and object relations themselves and the non-human ecologies in which they interact. 'Objects are never assembled together to form some other realm anyhow' (Latour 2005: 85). ANT analysis is 'not a matter of giving priority to "the material world alone"' since the aim is to supercede subject/object oppositions (Olsen 2010: 149). For Latour, the lack of dualism is a positive aspect of Actor Network Theory (see also Knappett 2005: 32). But to bring everything into the dispersed human/non-human network risks losing one of the main motors of change – the limited unfixed nature of things in themselves and their relationships with each other. There are many changes in natural cycles, in daily, monthly, annual, decadal, millennial rhythms. There are many processes of decay and loss and depletion that impinge on human society and in which things have unacknowledged and unforeseen effects. Because humans and nonhumans are thoroughly embroiled in each other, these material changes entangle humans, they force responses and adjustments.

In his account of a Manchester church (see Chapter 4), Edensor (2011) critiques ANT by arguing that there are forces outside actor networks that cause problems and lead to change. In the church, the behavior of salts, weather and chemicals do themselves produce change (Edensor 2011: 249). There is tension between human and non-human that is partly caused by the interactions of objects in ecological

settings. Latour (1992; see also Latour as Johnson 1988) describes how a speed bump acts to force people to be moral as they drive cars along a road in front of a school. Humans are forced to slow down or break up their cars – a morality is forced on them by the physical interactions between the car and the speed bump and the costs needed to repair a car that is driven fast over a speed bump. The speed bump acts as a delegate of humans and indeed in England it is called a 'sleeping policeman'. The car driver is 'policed' at a distance – there is no need for a police officer to be there in person. For Latour in such analyses, there is no separation between thing and society. In 2005 he abandoned the principle of symmetry between humans and things because 'the last thing I wanted was to give nature and society a new lease on life through "symmetry"' (2005: 76; see also Olsen 2007). As a result, in Latour's analyses things are always already caught up in networks of humans and non-humans and the object nature of things separate from society is not a key part of the analysis.

There are problems with the idea of a total mixing of humans and things in networks or meshes. At certain historical moments and in certain contexts humans appear dominant over things, but at other places and times things seem to have the dominant hand (for example during global warming at the end of the Pleistocene and perhaps during our own current experience of global warming). In ANT everything is relational and this insight is important. But it is also the case that materials and objects have affordances that are continuous from context to context. These material possibilities (whether instantiated or not) create potentials and constraints. So rather than talk of things and humans in meshworks or networks of inter-connections, it seems more accurate to talk of the dialectical tension of dependence and dependency, historically contingent. Rather than networks we seem caught; humans and things are stuck to each other. Rather than focusing on the web as a network we can see it as a sticky entrapment.

I have tried to encapsulate this notion of being stuck together in my attention to the word dependence, problematizing the concept by dividing it into various components - the reliance, the contingency (both in dependence) and the entrapment of dependency. It is especially the latter that produces the 'stickiness' between humans and things which in my view is inadequately dealt with in the networks and heterogeneous hybrids of ANT. It is the focus on being caught in all the forms of human-thing dependences that leads me to 'entanglement'.

The Archaeology of Entanglement

The first phase of the Nazi invasion of the Soviet Union in the Second World War in 1941 was called Operation Barbarossa. The Germans initially had the initiative, but there was rain in October and mud on the roads, and freezing conditions in November

with temperatures down to minus 20 degrees C. The Germans had no winter clothing, not even gloves as they were not expecting a winter campaign. The Germans did not have suitable lubricating oil so their guns did not work. The wireless batteries froze. The Russians were better equipped and the Germans were forced to retreat in January 1942 – although there were later advances again by the Germans. But for this one operation in 1941 one sees starkly the entanglement of people in things, with deadly results.

In this book I have gradually built up a description of the ways in which humans and things are entwined, involved with each other, dependent on each other, tied together. This account is relevant for all things on which humans have some impact, but it is especially relevant for things made by humans. I have tried to show that humans and things are both same and different and that unexpected interactions occur in the interstices between them. While much of what I will argue in this book about entanglement is closely aligned to the approaches taken in the social sciences and humanities (e.g. Brown 2001, 2003, Nuttall 2009), I take a specifically archaeological perspective based on two characteristics.

The Physical Processes of Things

Most approaches to entanglement do not deal specifically with the material properties of things (Ingold 2007a). I focus on the ways in which entanglements between people that involve things create specific practical entrapments. In Chapters 2–4 we saw that the material objectness of things tends to trap humans into specific forms of co-dependency. In the practices of daily life things fall apart, decay, run out, go wrong, need each other in sequence. Humans thus get entangled in this physicality – however much they do so within social worlds. There remains a component of the entanglement which is produced by things themselves. While these dimensions of things are incorporated within the sociology of science research, the archaeological direction is more directly attuned to the physical processes of things in themselves. For some in the sociology of science tradition, as we have seen, there is some doubt about whether physical processes could ever be separated out within the human-nonhuman hybrids. Archaeologists are more comfortable, given their detailed work with artifacts, recognizing that there are physical processes that occur that are separate from, however much they are infused with, the social realm.

The term 'entanglement' joins the many others that try to bridge the divide between materialism and social construction. I do not want to reintroduce a materialism or an environmental determinism, or an ecological imperative. Scholars in the humanities and social sciences have done much to appropriate ecological and environmental concerns into the socially constructed sphere. But the success of such scholarship does not hide the fact that real world issues entangle us in entrapments and necessities. Much as we engage in these necessities through our socially constructed worlds, they nevertheless draw us into their webs of interconnections.

Entanglement as a term aims to allow a materialism but embedded within the social, the historical, the contingent.

We have seen how the material attributes of smectitic clays entrapped humans into the care of houses at Çatalhöyük in Turkey 9000 years ago. Of course, houses can have much the same effect today. Consider a person who owns a house in USA which was built in 1790 and is a listed building of historic interest. The roof needs replacing, which involves getting a specialist roofer and specialist materials. The roof replacement might involve spending (in 2010) about $55 000 and thus requires the house owner to have a good job, to work hard, to sustain a set of social and economic relationships. It is not just the rotting of the beams in the roof that entraps humans in such entanglements. The entrapment is also caused by the way we have come to value old houses in the USA and by the interactions between decaying roofs and our historic sensitivities. It is these interactions that have resulted in regulations about listing historic buildings and have forced a compliance on us. So it is not just the building itself that entangles us – but also the ways in which we have come to construe and value old buildings.

We can take this example further by imagining that the house is worth $0.8 million but the owner has loans on the house that amount to $0.9 million. This situation of 'negative equity' is a good example of the way in which people get stuck in the web of things. The value of a house ends up being less than the loan owed on it. So it is impossible, or very difficult, for the owner to sell the house – the money received would not pay off the money owed. So the owner is saddled, caught, entangled in a set of debts and ownerships because of the material house, especially if the roof is rotting. Something has to be done to save the roof, but how is the $55 000 to be raised? But in this case again it is not just the house that entangles the owner; it is also the system of loans and the forms of ownership and the wider system of values and obligations that underpin the entanglement.

Entanglement is practical and it involves debts, duties, obligations. It also involves systems of general value in which these are embedded. For example, in a particular society like the USA it may be possible to 'own' a house even though the deeds are kept by a loan company or bank. Thus, ownership of a particular thing depends on wider ideas about ownership in a particular historical place and time. As we saw in Chapter 2, each society has its rules about who can own – for example, in other societies women may not be able to own houses. This discourse may then overlap into other thingly areas, for example influencing whether women can own cattle; or whether men can own women. So there is a continual interplay between our relationships with things and generalized systems of discourse and value. Rights and duties in one area thus extend out and get transferred to other areas.

It may be helpful to provide a further example of the ways in which material entanglements are simultaneously and seamlessly conceptual and social. Here is a puzzle. How is a plastic see-through letter- or post-box entangled with the Pentagon? As I was waiting in Heathrow, after finally being allowed off the plane with metal fatigue, I noticed a see-through post-box in the airport. Letter- or

pillar-boxes in England had always been red and cast iron, I suppose to protect letters from prying eyes, theft and the weather. This one was plastic and had a red front, but the back was transparent so that I could watch my letter fall in and lie there. But I could also see there was no bomb. The transparent post-box had been introduced after 9/11 and the flying of planes into the Twin Towers and the Pentagon, and after the general rise in terrorist threats, often targeted on airports. So the material entanglement in which post-boxes and the Pentagon were caught involved bombs and terrorists, and running through that entanglement was a climate of fear. So, again, a system of emotions and values was part of the human-thing entanglement that linked planes and bombs and post-boxes.

Humans work within webs of meaning that often seem arbitrary, symbolic and representational. Their abstract and generalizing thought processes are dependent on these webs, on language, on systems of representation. But very often, these same symbolic representations gain their salience from being embedded in sets of practices and experiences. Most material symbols in particular tend to be iconic and indexical (Preucel 2006); there tends to be some relationship between sign and referent. Notions of contiguity and association abound. I am not, thus, arguing for a separate world of symbolic representation. Even linguistic meanings are thoroughly embedded in practice (Preucel 2006, Peirce 1932, Searle 2000). My aim here has been to say that the webs and networks in which humans live are as much symbolic, meaningful, spiritual, religious, conceptual as they are practical and technical, economic and social. Thomas (1991: 9) finds that the symbolic world is 'practically muddled like everything else'. Keane (2003b) argues that signs and referents are bundled together in physical co-presence on objects. The web is seamlessly material and immaterial. The fear that is associated with post-boxes and planes today results from very specific historic circumstances that have heterogeneous dimensions.

So the term entanglement differs from materialism, ecological determinism, biological reductionism and the like. I argue that the source of transformation and constraint in human society is not in the material facts of existence but in the dependences between humans and things. We have to be careful here: clearly material objects and ecologies can themselves disrupt or have an impact on entanglements, as can intentional humans. Whether these stimuli (of whatever heterogeneous origin) lead to change or transformation of entanglements depends not on the materials (or intentions) themselves but on the form and tautness of the entanglement. The interlacings of the web are composed of bundles of material, ecological, economic, social, ideational, emotional and cognitive processes. Human movements to and away from things are made possible by, but are also bounded or channeled by, these bundles of material and immaterial interactions and dependences. These bundles make up strings or cables in which both humans and things are enabled and constrained. It is these multiple, co-dependent strands that create the webs in which societies are formed, endure and fall apart. The determination is produced not by an idealism or by a materialism but by the contingent ways in which the multiple strands of entanglement are tied together.

Entrapment is not produced by things, tools and environments in themselves but by all the forms of dependence summarized in the formula at the start of this chapter. In Chapters 2–4 we saw that humans are dispersed into things; and we also saw that things are dispersed into each other; and that things are dispersed into humans. So there is a mutual locking into a tangled skein. It is the totality of HT, TH, HH, TT that creates entrapment. All the dependences that things have on humans and on each other play a role at one and the same time as all the dependences that humans have on each other and on things. Humans get entrapped by the ways in which each node in the web is hyper-connected to other nodes, so that all nodes are maintained in position by the overall structure of the entanglement. The links are multi-stranded and practical and they involve notions of value and cost, ownership and identity, gift and debt as much as they involve the practical dependences of things on each other. In a practical everyday way, the chains of human-thing dependence provide us with opportunities and constraints. We seek pragmatically to make things work.

Temporalities

There is an important temporal dimension in entanglement. The dependence of things on humans means that humans are always busy along the strings or cables of entanglement mending things, putting fingers in dykes, fixing holes in buckets and so on. And because things and humans live in different temporalities, there is an unpredictability about where maintenance and innovation may next be needed. According to Achille Mbembe (2001: 14), the postcolony 'encloses multiple durées made up of discontinuities, reversals, inertias, and swings that overlay one another, interpenetrate one another: an entanglement'. Mbembe tries to replace the notion of time as an evolving series with time as an interlocking of pasts, presents and futures. There is non-linearity and chaos as past 'failures' are returned to and retrospectives abound (see also Nuttall 2009).

Material things play a large part in the unraveling of linear time. When I drive my car I am immediately and directly indebted to the invention of the wheel in the 4th millennium BC. When I eat my morning cereals, the wheats have genetic material that was first selected for during the domestication of plants in the Middle East eleven millennia ago. I noted in Chapter 4 that while the focus in behavioral approaches on how things work is important, the lack of consideration given to history limits the ability to understand entanglement. We can take as an example my wrist watch. I depend on the watch to get me to work on time, finish my lectures on time, be the sort of person I want to be (punctual – not early not late). This is the type of dependence discussed in Chapter 2. But the watch also depends on the leather strap and metal clasp to stay on my wrist (Chapter 3) and it depends on me to replace the battery when it runs out, and to replace the strap as it wears out or gets dirty (Chapter 4). The watch also depends on a vast edifice of spatial and temporal connections as we began to see in Chapter 4.

In Chapter 1 we saw how the yearly calendar on which the date on my watch is based was first fixed by Julius Caesar and then by a Gregorian calendar. The system of 12 hours and 60 minutes is based on the mathematics of the Sumerians and the time systems of the Babylonians and ancient Egyptians (Dohrn-van Rossum 1996). Ptolemy subdivided each of the 360 degrees of latitude and longitude into smaller segments that became known as minutes (*partes minutae primae*) and seconds (*partes minutae secundae*). But minutes and seconds could not be used for everyday timekeeping until the development of mechanical clocks, especially the spring powered clocks of the 1500s. By the end of the 16th century these were able to display minutes.

But how do I know what time to set my wrist watch to? The time is based on a global system of time keeping which has developed over centuries with the expansion of empire, mechanized travel and global capital. As Britain developed its international trade, Greenwich Mean Time (GMT) was established in 1675 in order to aid those at sea to determine longitude – although that itself depended on inventing a clock that could withstand the rocking and buffeting of ship movements (by John Harrison in the 1760s and 1770s). GMT was based on the use of telescopes at Greenwich to measure mean solar time. Gradually, through trade and imperial networks, GMT was adopted worldwide as a reference time (Howse 1980). But the first time zone in the world was established not at sea but by British railway companies in 1847 to replace the variable times in towns and cities around Britain and in 1883 four time zones were established for the railroad systems of the United States. Between 1880 and 1930, most major countries had adopted hourly time zones based on GMT. Greater needs for travel, communication and trade, associated with advances in the calculation of time using electronic and atomic clocks led to further international standards. In 1976 the second was redefined as the duration of 9 192 631 770 energy transitions of the cesium atom and in 1972 GMT was replaced by Coordinated Universal Time as the international time reference, maintained by atomic clocks around the world.

Time has its social, political, economic and religious contexts. Le Goff (1960) describes the differences between church time and market or merchant time in medieval Europe, and Marx drew attention to the role of the technical rationality of the clock in the regulation and alienation of labor under capitalism (Thompson 1967). Today the pace of our lives is measured in micro-seconds as we surf the web, conduct international business in stocks and shares and race to airports. Humans have become increasingly regulated by time. My watch produces a particular type of person and life. A vast edifice of humans and histories, things and their connections stretched out over years, centuries and millennia and spread out from Greenwich to every part of the globe traps me into a particular way of being. It is the actual watch with its circuits and hands as well as the institutions and global agreements that trap me. But the connections seem unfathomable. They have no end, involving wheels, ships, trains, telescopes, springs and atoms, satellites, countless engineers, politicians making international agreements,

mappers, astronomers and mathematicians – all spread out over millennia and present within my watch and its working in relation to me. So the me in California that looks at his watch as he gets ready to call a colleague in Turkey is caught within, and is invested in maintaining, a time system with its own temporality: one that links me directly to Julius Caesar and John Harrison, the first wheel and the discovery of the atom. The person I can be depends on this particular temporal conjuncture of humans and things, institutions and practices.

There is more to history than a linear account of sequences of events; there is also the material history, the heritage of past acts, the detritus of past millennia that bumps up against us in a non-linear way (Lucas 2005). It is this material history that continues to play a role in the present. We have seen how refuse builds up, creating problems for future generations. Past generations create environmental problems for future generations. Human-thing entanglement at one point in time directs where future action can take place. In Britain today many roads in cities and across landscapes are Roman in origin. Once built a road connects to other roads, and to buildings and facilities along roads. The roads are difficult to change because there is so much connected to them. In the 1960s/1970s there was discussion of changing driving in Britain so that people drove on the right of the road as on the continent, where the habit of driving on the right had been spread by Napoleon. But the costs were deemed too high. Not only car production would have to change, but road signs, intersections, access to buildings and airports and so on. So the legacy of Napoleon and his failure to conquer Britain lives on in Europe – not because of the story of Napoleon although that played an initial role, but because his material legacy has been invested in and absorbed into the economic and social fabric of society.

And the things in this system exist in their own temporalities and so affect us in unexpected ways. Some hangover from previous decisions made in the growth of a system can suddenly hit us unawares causing adjustments at potentially great costs. As an example we can return to the example of time-keeping. As the year 2000 approached it was suddenly realized that a great calamity was imminent – the millennium bug or the Y2K problem. The problem arose because many computer systems had been set to store information about the year as only two digits. Thus 1910 was often stored as 10, and would thus be indistinguishable from 2010. In other computer systems it was thought that a computer might try to represent 2000 as 19100. Banking and data storage systems were put at risk and companies spent very large sums globally in order to rectify the recording of years. In the event the dangers to information systems may have been exaggerated, but there can be no denying the disruption and costs. Committees were set up by governments, experts employed and books written (Murray 1984). The United States government passed the 'Year 2000 Information and Readiness Disclosure Act'. It is estimated that the total global cost of work done in preparation for Y2K was 300 billion US dollars (BBC News – 6 January 2000). The reduction of four to two digits to represent years derived from the costs of computer memory in the 1960s and the effort to save

space on 80-column punch cards. This two digit system on cards was carried over into later digital systems. It was not until the particular conjunction of this system and the year 2000 that a potential crisis was recognized.

Humans and things have their different temporalities. Within all the entanglements, within all the complex flows and dependences, there are transformations of things that can suddenly burst out. A dam may suddenly burst through, a volcano may explode, the mud on a hillside may unexpectedly slip down and smother a village, a shift in the axis of the earth may force a resetting of the global network of atomic clocks. Decisions made in earlier times about the preference for cars fueled by petrol rather than by electricity in turn impact on later decisions about supplies of oil, international trade and warfare and global warming. Reasonable decisions at the time in which holes were punched in cards have an enormous impact on computers and information systems 30–40 years later. Humans are forever working along the strands and cables of their webs fixing things, putting things right as past decisions made by past generations, even generations millennia ago, come back to have impact.

Forgetness

Entanglements have components that have deep histories. We saw in Chapter 4 that humans at Çatalhöyük in Turkey 9000 years ago depended on wild cattle for social status, beliefs, feasting, social display. This heavy use of wild cattle may have led to a depletion of cattle in the landscape and the introduction of smaller domestic cattle from farther east. But Diamond (1997) argues that the close association between humans and cattle in domestic settlements led to the spread of diseases from cattle to humans in the form of measles and tuberculosis. He further argues that human populations in Eurasia built up some degree of resistance to these and other diseases linked to domestic stock. Human populations in the New World, however, did not have cattle, sheep, goat and pig and did not develop any degree of resistance to the accompanying diseases. When Europeans came to the New World they brought the diseases leading to large-scale population decline amongst native Americans. After 10 500 years, the repercussions were felt of a Neolithic entanglement that had become a taken-for-granted part of life in Eurasia (see Wilcox 2009 for a more complex account).

There are many other examples. Since the Neolithic of the Middle East, humans and domestic cattle have increasingly become entangled such that today the need to feed vast herds has led to deforestation in the Amazon and to a major contribution to global warming. We did not see it coming that the invention of the wheel in the 4th millennium BC together with the development of the internal combustion engine in the 19th century would lead to conflicts over access to oil in the Middle East and further contributions to global warming.

We tend to forget the history of things. They can easily become taken-for-granted. We use them as we find them, working with them on the day-to-day, blind to the complex entanglements that have great historical depth. There were early warnings about the Y2K problem but few paid much attention until near the time. I was fascinated by the example of my wrist watch because I live with and use my watch oblivious to the enormous spans of spatial and temporal links in which it is entangled.

One of the reasons we are entrapped in things is that we do not see them or we forget them, even though they are still present and potentially active. In Chapter 2 I discussed levels of consciousness in relation to things, our reflective and non-reflective awareness of them as discussed by many authors from Pitt-Rivers and Heidegger to Leroi-Gourhan and Beckaert. Much of our interaction with things occurs at the non-reflective level. Things are there, on the table in the hall, but they can become invisible to us, part of the background, the frame of our lives. I also referred in Chapter 1 to the ways in which the workings of things are often hidden at the back, removed from view. The historical archaeologist James Deetz (1967) wrote of 'small things forgotten' and a book on the global dependencies of contemporary artifacts is subtitled 'the secret lives of everyday things' (Ryan and Durning 1997).

ANT uses the term 'punctualisation' to refer to the ways in which actors, relations, institutions, and objects come to be concealed from view (Law 1992) in order to provide the appearance of unity. John Law describes a television set, which most of the time is 'a single and coherent object with relatively few apparent parts. On the other hand when it breaks down, for that same user—and still more for the repair person—it rapidly turns into a network of electronic components and human interventions' (1992: 4). Much of the engine and workings of a car are hidden from the average driver who just knows about pedals and steering wheels – but depunctualization occurs when things break down and humans become aware of the engine.

Why does this forgetness occur?

- Because in order to use something we do not need to know how it works unless it breaks down. We manage on the day-to-day without knowing the theories and histories of things.
- Because of the non-reflective routinization of our every-day relationship with things.
- Because the workings of things are often hidden, concealed in back regions of daily life.
- Because the strings of entanglement are so long, complex and 'chaotic' that it is difficult for people to monitor and understand and predict. According to ANT some things are too large, too complex, or too fleeting and ephemeral to be grasped in their entirety by one person (Preda 1999: 350).
- Because of the different temporalities of humans and things. A wall erodes or leans over at a pace too slow for most humans to bother with. That is until the wall is about to collapse or fall over.

- Because things go out of use as entanglements transform. Returning to the example of the pebble collected from a beach that I used in Chapter 2, the pebble gradually becomes associated with and owned by a person or family, but it is also common for a pebble collected from a beach and placed in a box in a drawer at home, or placed on a shelf in the bathroom to be there so long that the inhabitants of the house forget what it is and what memories it evoked. When the house is sold it may be part of the 'junk' that is thrown out onto landfill.
- Because things become distanced in place and time. Thus I might make an object and it is a thing for me, but it moves away from me and becomes separate from, distant from its context of production and use. With the passage of time, through exchange, or decay, the thing threatens to become distant, object-like. There may be traces on the object of its history, but its history comes with it only partially. The object is too easily de- or re-contextualized.

The effect of all this forgetness is that humans get entangled unwittingly. Things and their connections and dependences have implications and consequences of which people are not aware and which may be unintended (Giddens 1979). But suddenly the things return or transform and have to be dealt with. Suddenly the junk gets so large that it has to be moved or recycled. Suddenly global warming becomes obvious enough that something has to be done. Suddenly we take note of Y2K and spend huge amounts of resources to mitigate the problem.

The Tautness of Entanglements

Earlier in this chapter I referred to Darwin's entangled bank. So what is the difference between the use of the term entanglement in this book and the use of the term to refer to ecological symbiosis and mutual or co-evolution? The main difference is that entanglement as the term is used here involves dependency. The species in Darwin's entangled bank are engaged in symbiotic relationships. The flower and the bee depend on each other mutually. Species co-evolve and in this way they are tied together. But the bee does not tend the flower to make it grow. Theirs is a relation of dependence as I have defined it in this book. But when humans domesticated plants they did not just harvest or forage – they cultivated and sowed and weeded. There is a single bind between flower and bee. But the human is caught in a double bind with the domesticated wheat in that the human has also to make the wheat grow. As humans increasingly live in a world they have produced, they have to work harder to reproduce that world on which they depend. This is dependency.

As already noted, the tautness of entanglements is produced by the totality of the HT, TT, TH and HH dependences and dependencies. More specifically entrapment or tautness within entanglements occurs for a number of reasons, including the following.

- The things humans have affected and depend on need constant reproduction and care: dependency involves constraint.
- As described in Chapter 3, there are bottle-necks and hold-ups in the carrying out of any complex action. We have to wait for the pot to dry before it can be fired. The different temporalities of things and humans impede each other. Things get stacked up in relation to each other, constraining each other along operational chains.
- As described at the end of Chapter 4, dealing with the unruliness of things in relation to humans leads to regulation and discipline.
- We have invested labor, resources, time in things and wish to protect that investment.
- We have come to depend on the positive benefits deriving from the greater flows of resources and information through the network.
- Various forms of ownership of things may lead to rights and obligations towards each other. Inequality usually involves the control of resources by dominant groups and the restriction of access to others.
- In exchange, there is an obligation to return a gift.
- The multiplicity of the links in the entanglement creates entrapment. To make a change at one place has impacts in many other places.

Underlying all these aspects of entrapment within entanglement is one simple and utterly obvious fact – that what we do at one moment is channeled by what we did previously. I will discuss the roles of trajectories in relation to entanglement more fully in Chapter 8, but for the moment I want to point out that the historical role of things is not simply linear so that a affects b affects c affects d. While such historical sequences can be described in relation to events, things have temporalities such that a may affect d directly. I gave many examples above. When I drive my car I am directly connected to the invention of the wheel six millennia ago. In England I often drive directly on a Roman road. The millennium bug of 2000 resulted from decisions made in the 1960s. Things and the effects of things endure across temporalities very different from humans and the events that so occupy them.

We often talk of such processes as 'digging ourselves into a hole', as archaeologists know better than most. When I excavate at Çatalhöyük I dig a trench or hole in the ground and from long and bitter experience I know that the hole I dig restricts later actions. For example, as I dig I decide where to place the earth from the hole. If I place the earth in a large heap on one side of the trench it becomes very difficult to expand the trench in that direction – I would need to expend much labor and costs moving the heap of spoil before I could dig under it. In any case, as the trench is made deeper, any expansion sideways at the bottom involves moving a lot of earth at the top. And then there are our efforts to deal with the unruliness of things. At Çatalhöyük we follow UK Health and Safety regulations so that we do not dig straight down but step in the trench gradually as we go down. So the trench gets smaller and smaller as we go down in case the deposits we have dug

through shift and collapse on the excavators. So expanding sideways a small distance at the bottom of the trench involves expanding much larger distances at the top of the trench. Archaeologists very much dig themselves into holes so that earlier material decisions constrain later action. This is true of most material action. It becomes very costly to change road systems, stop global warming, get rid of the millennium bug because we have dug ourselves into real material holes that need a lot of fixing. Tautness is partly an historical product.

Many of these ideas about humans becoming locked into entangled webs are components of path dependence as discussed in economics (David 1985), political science (Pierson 2000), sociology (Mahoney 2000) and to a lesser extent archaeology (e.g. Lucas 2008, Hegmon *et al.* 2008). In a well-known study of the persistence of the QWERTY arrangement of letters on a keyboard, David (1985: 332) argues that 'a path-dependent sequence of economic changes is one of which important influences upon the eventual outcome can be exerted by temporally remote events, including happenings dominated by chance elements rather than systematic forces.' The lock-in effect from remote events occurs, from an economist's point of view, largely because the costs of switching from one alternative to another increase over time. The costs of exit from a particular strategy rise through time. Path dependence in the social sciences is also linked to other additional factors that inhibit switching paths. These include the presence of a linked infrastructure which itself is difficult to change; for example, changing paths in car design and use has to contend with the entanglements between cars, road systems and networks of fueling stations (Pierson 2008). Other factors that create path dependence are law and convention, systems of authority and power differentials. There are thus many similarities between path dependence and the entrapment of entanglement, particularly the idea of getting locked into paths that become difficult or expensive to change so that early choices have a great effect on later action. But entanglement theory attempts to define dependence more fully and to focus particularly on the practical material interlacings of humans and things.

Types and Degrees of Entanglement

Can we say something provisional about types and degrees of entanglement? A first point to make is that entanglements (sets of inter-linked dependences between humans and things) are not necessarily complete and holistic. They are not like cultures and systems. They can be very localized, partial and marginal. Entanglements are identified empirically as specific flows of matter, energy and information. Some are hyper-connected and very far-flung. Others are local, short-term and disengaged. Practices that produce carbon emissions affect us all today, but my fixing of a tap in a house on one side of London may well be unrelated to the stumbling over the piano keys of a student playing the Moonlight Sonata on the

other side. At Çatalhöyük it remains to be demonstrated whether any links can be found between pottery production and burial practices. We need to search for any empirical evidence of associations or oppositions that might suggest some linkage between the entanglements surrounding burial and those surrounding pottery.

So entanglements are always specific and local, but they are also open-ended. Thus in the case of the tap fixing and the piano playing on different sides of London, both may be interrupted by a news item on TV or both the tap and the piano may have metal components obtained from the same source. In the diagrams shown in Figures 3.1 and 3.2 it is always possible to go on outwards, for example in Figure 3.1 from the fire to the fuel to the basket to contain the fuel to the reed used to make the basket to the tool used to cut the reed to the obsidian from which the tool was made to the mountain from where it was obtained and so on. These are the heterogeneous strings of entanglement along which humans are continually drawn in order to carry out maintenance and fixing.

The degree to which humans and things are entangled partly relates to the length of connected but often invisible links that are involved. Despite the open-ended nature of the links around the fire, the number of links and their length are greater for the use of clay at Çatalhöyük (Figure 3.2). But each of these entanglements is miniscule in relation to the 1–20 000 parts needed for the modern car, obtained from all parts of the globe and involving trade agreements, tax systems, bureaucratic procedures and transport systems. And in our world the car is a small thing compared with the entanglements of all the parts in a ship, or in an airplane.

Some things seem to entangle more than others. I have pointed several times to the ways in which the cultivation and then domestication of plants entrapped people into a dense and complex entanglement. Cereal domestication locks humans into greater labor per unit of land as ground is cleared, prepared, dug over, seeds are planted followed by weeding, protecting from animals, harvesting, threshing, winnowing, roasting, pounding, grinding. And all this investment is returned over the long-term, leading to obligations, debts, ownership. The early use of domestic sheep on the other hand seems to involve less entrapment. As noted in Chapter 4, the behavior of wild sheep can be made use of by humans as they make use of the existing dominance hierarchies in the flocks, the tendency of flocks to follow leaders and to move limited distances around the landscape. Certainly entrapments occurred as breeding was increasingly controlled, as pens had to be made, as animals had to be kept off crops. If animals were domesticated as much for milk, wool and portage the degrees of entanglement would have been greater. But in general terms it is clear that some things require more investment from humans and more involvement from other things.

It might be thought that one could argue for some generalization about entanglement that related the degree of entanglement with the technological complexity of the object. Thus very simple and widely available objects might be expected to have fewer material, practical, human entanglements than complex objects made with parts that are scarce. Thus a pebble from the river bed used to

smooth a plaster wall at Çatalhöyük is likely to have involved less entanglement than a (serpentine) bead that had to be traded over long distances and took a significant amount of technology to drill and polish. In our own times, a car involves fewer entanglements that an airplane. However, if we turn from the material entanglements to all the wider forms of entanglement, the social, religious, ideological, semiotic, phenomenological and so on, we quickly see that the generalization is difficult to maintain. Collections of similarly-sized white pebbles were collected and cached in the floors in houses at Çatalhöyük. We do not know their significance, but in some way these objects were selected out and treated specially. And some cars, because of their use in films (the Bond cars for example), or because they won a particular Grand Prix or were driven by a famous driver in his or her last race, take on a special social significance that may involve entanglements as great as or greater than a normal airplane. Because entanglement is both material and immaterial, involving debts, values, ownership and beliefs, it is not possible to generalize a priori about the overall entanglements of an object, although the material side certainly helps as a starting point in evaluating entanglement.

Despite their open-endedness, heterogeneity and historical specificity, entanglements can often be characterized using general terms. They may be strong, weak, integrated, redundant, concentrated, dispersed and so on. In Chapter 3 I gave the example of a sail boat in which all the many parts depend on one small 1 inch long piece of metal – a small pin on the shackle that links the top of the mainsail to the halyard that pulls up and keeps up the mainsail. Without this minute item the boat does not work. Without it one cannot sail, even if everything else is working fine.

We have all come across similar situations – where one has a perfectly functioning engine or system, except for one small part. We could call such systems highly integrated. In other systems, it might be possible to manage without a part (and even on the sail boat there may be some parts which are less important). For example, in a rowing eight, if one person falls out and takes his or her oar with him or her, the boat can still be rowed, if not so efficiently as before. This entanglement is less integrated and more dispersed. Some systems have large numbers of equivalent parts, they may be low technology, and we might call them redundant or simple. We could in fact borrow the language of complex systems (Bentley and Maschner 2003) for such distinctions as will be discussed in Chapter 8. We might go farther and suggest that certain types of complex system are more efficient at carrying out certain tasks, or that different types are more or less prone to change, and so on.

An alternative vocabulary is provided by Jean Baudrillard's (1996) 'system of objects'. Baudrillard describes how a system like the car engine starts off having independent entities or units in it, but through time the design of the car engine changes so that the parts come to be more dedicated to the functioning of the system as a whole – that is the engine and its parts become more integrated, achieving a functional synthesis. The parts in these systems he calls 'technemes' on

the analogy with language. Baudrillard also notes that the technical functional system of everyday objects can be at odds with larger systems of cultural needs. Thus both within the car engine and in the relationship of the car engine to wider entanglements there can be degrees of integration, changing through time.

While awareness of such variation is important, it is not my aim to produce a classification of entanglements. My own view is that it is more helpful to focus on the variety of entanglements and their historical specificity. I also wish to insist on the difference between the ideas of entanglement and system (however complex, open and chaotic they may be). As noted above, entanglements involve notions of dependency and entrapment. They thus have histories that need interpreting, debts and obligations that need understanding, modes of labor organization involving inequalities. Entanglements are heterogeneous involving beliefs and values. It is not enough simply to model the contingent flows of energy, matter and information through a system since the fact of being caught up within an entanglement also involves power, history, beliefs, values and material practices. As we will see again in Chapter 8, the study of complex systems needs to be located within wider social and historical theory that deals with the interpretation of human skills, perceptions, and engagements and is sensitive to the practical holes into which we dig ourselves.

Cores and Peripheries of Entanglements

The small pin on the shackle that holds up the sail at the top of the mast is essential. It is core to the functioning of the boat – that it sails. For many sailors it does not matter so much what the tell-tale (that indicates the wind direction) is made of, or whether the stove, toilet and the sinks work. On my own boat sometimes I find I have been wrong about the importance of components of the boat. On one outing I decided that it did not matter that the battery was flat. But as a result I got stuck on a sand bank that day. The battery runs the depth sounder. Without it I did not see that there was a sandbank in my way. But for others who come on my boat the small pin in the shackle and the battery matter even less. For some, the stove and sink are more essential because the main function of the sail boat for them is not to sail but to relax, eat and entertain. So, once again, entanglements are related to perspective, purpose, belief. The relative importance of parts of the entanglement, whether they are central or peripheral, depends on the purpose of the functioning.

So far I have described the functioning of the sail boat in terms of its functioning to sail or entertain. But in either case there are additional entanglements that need considering. The boat is sailed and moored in a bay and the bay is an ecological system in which there are other boats, plants, animals, fish, insects and so on. The use of boats in the bay leads to increasing regulation of the behavior of boats and boat owners, including what is painted on the hulls, how many moorings are allowed, and how effluent is managed on the boats. In this wider set of entanglements in

which the Coast Guard and Park Service are most interested it is the paint on the hull and the toilet system that become core issues.

Of course I can exert power over those that come on my boat and insist that all items to do with entertainment are of secondary importance when it comes to spending time and money on them. But it is also possible for the Park Service to override my interests and exert their power over my boat, extracting it from the water if it does not follow anti-pollution guidelines. Core and peripheries in entanglements are often defined by the power of dominant groups in the centers, such that development in the periphery is constrained and channeled by the center. This is of course one of the main themes of the debate about the cores and peripheries of states and empires in World Systems (Stein 1999). As is clear from my frequent reference to scholars such as Thomas (1991) and Nuttall (2009), my use of the term entanglement is much indebted to post-colonial studies of the dependencies that emerge in core-periphery relations within world economic systems. Much of these arguments can be transferred to other forms of entanglement, most of which have cores and peripheries of their own.

The relationships between core and peripheral parts of entanglements change through time. In the early and middle parts of the 1400 year sequence at Çatalhöyük, the main social interest was in entanglements that had to do with burial, history making, feasting and wild animals (Hodder 2006b). It is the wild animals that are shown in the art, and it is their horns that are installed in houses. Art and decoration are found in houses, often related to the treatment of ancestors buried beneath the floors. Domesticated animals and plants seem peripheral at this time. Neither are shown in the art, the pots used to process domestic sheep and goat fat are not decorated, and the bins used for storing cereals are not decorated. The processing of domestic animals and plants seems almost unnoticed within the dominant social perspective. But it is in this peripheral arena that things start to change, with greater dependence on and intensification of animal and plant domesticates through time. In the upper levels of the site there is more evidence for intensive use of plants and animals. Wild cattle play little role in the economy and socially. Adult burial no longer occurs in houses by the time of the Çatalhöyük West Mound (Chalcolithic). Hearths move into the center of the main room in the house rather than being peripheral to it, and domestic pottery is elaborately decorated. Change that started in peripheral areas in the lower layers in the mound becomes central in the upper levels. Entanglements have cores and peripheries that change according to perspective, power, and historical context.

Contingency

> 'It is perhaps this instability, historicity, and lack of historical containment that epitomizes the entanglement we all have with objects.'
>
> (Thomas 1991: 208)

We often talk of societies as if they were coherent units that every now and then have to deal with and adapt to change. Societies are often seen as evolving and adapting in an orderly manner. Alternative new models describe a more chaotic process in which there is a large degree of uncertainty and contingency. I will explore these ideas from chaos and complexity theories in relation to entanglement in Chapter 8. For the moment I want to point to the ways in which the open-endedness of entanglements, the long threads of which they are composed, the unruliness of things, the unexpected clashes between the different temporalities of humans and things, the historical specificity of the practical holes we have dug ourselves into, mean that entanglements are always provisional, worked out in practice, temporary and partial. Things are always happening that have to be dealt with in a continual boot-strapping process. Simple material events in one domain might have all sorts of unexpected spin offs. In 'A long way down', Nick Hornby (2005) describes a man who became a priest because he went into a shed and the lock slipped and he could not get out. In the long darkness he found God. One cannot argue that the lock caused the finding of God, but it is these odd and unpredictable entrapments with things that make up so much of social life.

Approaches to societies, economies and cultures that focus on systems and structures differ from those that explore the messiness and contingency of entanglements. Entanglements are difficult to understand and control because they are not contained and are difficult to predict because of the strands that seem to spread out everywhere. They are practical and every-day, involving real forces as much as imagined ones. They are in continual movement as events happen unexpectedly and are multiplied in their effects along the complex heterogeneous strings and pathways.

In Chapter 1 I referred to riding a bicycle as an example and metaphor of the ways in which human-thing entanglement involves movement. When the bicycle lies on the ground, apparently motionless on its own, the entanglements are limited. The bicycle goes through a process of decay, but it does not function as a bicycle until it is picked up and ridden. I remember taking that first bike ride, trying time and again to stay on the bike as it went down a slight slope. I remember the exhilaration of finally being able to stay on the bike as we picked up speed; I remember the moment of trusting myself to the bike and me on the bike. In motion the bike had become dependent on me; and I had become a bike rider, able to move at speed and go where I wanted. I was free to ride away from home, but was yet trapped in the movement of the bike. I had to keep going or fall off. I and the bike could only function in relation to each other if we kept the momentum up. And at any moment a bump in the road, a sharp corner, my shoe laces caught in the chain, could end the exhilaration.

The entanglement between humans and things always involves some of this movement in co-dependence as investments in things are made, managed and curated and as the unpredictable unruliness of things threatens to get out of

control. Humans in their relation to things are always running, or riding, or sailing to stay in the same place. What one does not see in the bike-riding example is the huge wake of entanglements that make this one entanglement possible, including my parents' income at the time, the international trade that brought rubber, metal, oil and plastic to England, the invention of the bicycle in the 19th century linked to social movements (Bijker 1997) but also to technological developments in chains and tires and ball-bearings. My small experience of individual freedom multiplied over entire populations created a demand for materials that produced bikes but at the same time entrapped humans into yet more intensive extractive and industrial entanglements. Municipalities across the globe have had to introduce traffic regulations to ensure the safety of bike riders. Keeping moving on bikes involves keeping moving in order to produce, maintain, use and discard bikes.

If I am to keep riding my bike today a lot else has to keep going to keep me moving. Ryan and Durning (1997) have studied the entanglements of a bike. A 30 pound bike in the USA is made mostly of steel, aluminum, rubber and plastics. The steel in the bike began in a Chicago junkyard. The scrap was sorted and delivered to a mill where it was melted down in an electric-arc furnace. Once the steel had been molded into tubes a truck took them to a factory in Wisconsin where they were cut, sanded, cleaned with chemicals and sprayed with paint. Once painted the frame went to an assembly line in the same factory where all the parts were added on. The gears, brakes, spokes were made of aluminum which was obtained in Siberia by smelting Australian bauxite ore using hydroelectricity from a dam near Lake Baikal. The nylon cable guides were made in Delaware, the polyurethane handlebar grips were made in Italy, the tires were made of butadiene rubber from Taiwan. Each one of these material entanglements involved payments, regulations, bureaucracies, obligations, debts, ownership and the full gamut of human social, economic and ideological relations. All are brought into movement and depend on each other, trap each other into a vast expanding web as I gather pace down the hill on my bike.

Conclusion

So societies appear to be made up of humans interacting with each other, forming groups and associations, entering into various forms of relationship with each other, forming governments and exercising power. It has long been accepted that material things are involved in this process, assisting in the exchanges of matter, energy and information. But the material things do more than facilitate. They tie the webs of interaction with dependence (the more general term involving both dependence and dependency as defined in Chapter 2).

I have tried in this chapter to carve out a specific definition for entanglement and to differentiate it from related notions such as networks, systems, structures,

societies, cultures. The distinctive aspect of entanglement derives from the attention given to the term 'depend' in the relationships between things and between humans and things. Dependence, as described in Chapter 2, involves reliance and contingency, and constraint in the notion of 'dependency'. Humans get caught in a double bind in relation to things since they both rely on things (dependence) and have to reproduce things they have made (dependency). And since humans and things depend on other humans and other things along long chains, the dependences are spread out across space and time. And as things are unruly and unstable, humans are forever chasing along the chains to fix things, forever drawn into further dependences.

The chains of the entanglements are heterogeneous. It is the skein of tangled links that plays determinative roles in human social life. I have therefore been unabashedly able to embrace both a degree of materialism and a degree of idealism. This is because the determinative factors in human action are neither material nor ideal. What is determinative is the entanglement itself, the totality of the links which hold and produce individual events, things, humans.

The notion that humans dig themselves into the holes of human-thing dependences does indeed appear very determinative. Once a hole has been dug, there are very few options left moving forward. On the other hand, we have seen that entanglements are open, far flung and contingent – things keep happening as the different temporalities of things collide and as things run out, break down and fall apart. Like riding a bicycle, humans are always involved in making adjustments in order to keep things going. There is a tension between the historical build up of ever more intricate and constraining dependences and the open and contingent nature of entanglements.

I will return to many of the themes of this chapter, especially movement and change, contingency, complex systems and trajectories in Chapters 7 and 8. But we need first to look more closely at how entanglements are put together. Are they really just contingent intersections – or is there something that holds them together – something other than 'society' or 'culture'? How do some things come into play more appropriately than others?

Chapter 6
Fittingness

Humans and things have attributes that 'fit' or 'come into play' in specific historical contexts. The adjective and verb 'fit' has two broad but closely related senses (Webster Dictionary). The first is 'adapted to an end or design'. The second is 'acceptable from a particular viewpoint' or 'harmonized with'. The first sense seems related to function – whether an attribute affords a human or thing the ability to function; the second to coherence of assembly – whether an attribute fits together with other attributes. In scholarly discourse, the first is often related to adaptive fitness and the second to meaning and culture and, as such, the two types of 'fit' have often ended up on opposed sides of disciplinary debates. I intend to try to use the term fittingness to cover both aspects of fit and to emphasize their dependence on each other.

Any human or thing has 'n' properties that could be listed and defined. But only in certain contexts do these properties have value to or are useful to human action. Properties 'come into play' by **affording** types of action that achieve an end. Affordance, discussed in Chapter 3 and further below, is one type of fittingness, dealing with how things work in relation to some project. Thus the pin on the shackle affords the sailor to hold up the sail on the mast and thus to sail. But we might also say that this type of threaded pin on this type of shackle on this type of boat is **coherent** with a particular life-style and concept of leisure that the sailor enjoys. Here the fittingness is not only about whether the shackle works but also about whether it seems appropriate within a phenomenal world of concepts, emotions and feelings. But note how closely affordance and coherence are linked. We have seen that entanglements involve material and technical as well as immaterial, symbolic and conceptual components. Entanglements involve perceived functions (of the role of the boat for example). We have also seen that material symbolism is

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based on indexical and iconic relations between meanings and referents. Thus the small screwed pin that closes the shackle on the boat only affords technical possibilities that cohere within (make sense within) a wider frame.

Nested Fittingness

Fittingness is nested and multi-scalar in the cases of both affordance and coherence. For example, the game of tennis has changed through time, and certain things 'fit' better at different times. As tennis has become more of a high-pressure sport, with mass audiences and huge prize monies, players have increasingly contested decisions by line judges and referees. And judgement of whether a ball is in or out has become more difficult as the speed of service has reached 100 to 150 mph. As a result a new technology has been introduced. A laser machine emits a 'beep' whenever the ball is outside the white line in the service box. The beeper takes away personal judgement. Judgement has been delegated to a machine – although it is treated like a fallible person, and the referee can over-rule the beeper. Another machine called 'Hawk Eye' is used by television companies to discern whether the ball is in or out, or on the line. But people did not initially trust this machine and so it was not used by the referee at Wimbledon in 2008.

A beeper or a Hawk Eye would not have made sense in the time of Perry or Laver. Back in the time of amateur sport there was less at stake. Today, as a result of television and advertising amongst many other factors, the winner of Wimbledon gets over 600 000 UK pounds and overall every year Wimbledon Lawn Tennis Club hands out over 10 million UK pounds in prizes, and the other financial benefits for successful players from advertising and endorsements are enormous. In such a highly competitive, high stake context each uncertain line call costs and is endlessly argued over. Before World War II 'gentlemen' played tennis and did not argue with the referee, hence the initial negative response to the un-gentlemanly behavior of those like McEnroe who started shouting at the referee.

So here we see a nested hierarchy of fittingness:

Beeper

Tennis

Wider entanglement

The beeper technology comes into being because it has a role in the game of tennis, but only at the particular point where professional tennis fits into the larger context of a mass spectator sport with high income rewards. One would not use a beeper in a local club or on a court in a friend's back garden. One could extend the hierarchy further – to the larger context of high capitalism in which making money is sought and is thought achievable regardless of background. But the main point is that fittingness is nested and hierarchical.

Perhaps a dominant theme of this tennis example is affordance. At other times the dominant theme may be aesthetic coherence. So in tonal music a note fits in because it creates harmony. In the scale of 'C' certain notes and harmonies and certain note sequences are seen as fitting. In the tonal system of classical and romantic music some notes are more important than others. These are the notes that are part of the 8-note scale (do-re-me-fa, etc.). Other notes, such as F# in the C scale (equivalent to fa#) are of secondary importance. By the time of World War I music began to be written that used an atonal system in which all 12 tones or notes in the scale had equal importance (all the notes being all the black and white keys on a piano). In such a context F# has equal importance to all other notes. As we will see below, the production of this new type of atonal music at the start of the 20th century is related to wider social and political changes.

So again there is a nested hierarchy of fittingness:

A note

A type of music

Wider society

Entities (beepers or F#s) get selected which are fitting at one level and which allow further fitting at other levels.

Return to Affordance

The shackle on the sail boat affords the holding up of the sail because of what it is made of and its exact shape and size. The threaded pin has to fit neatly into the shackle. If it did not, the pin and the shackle would not work, they would not afford the desired function. Archaeologists have discussed such affordances in relation to many material processes, especially metal, stone, bone and ceramic production. For example, van der Leeuw (2008) provides diagrammatic summaries (e.g. Figure 6.1) of the factors that have to be taken into account in preparing paste, in getting materials, and so in making pots. He discusses many examples of affordances (potentials and constraints) offered by the materials, by the economic system and by social tradition. A water jar has to have a high center of gravity, a handle, a spout and the vessel wall has to be waterproof. Affordances are produced by workshop organization and marketing and by the tools available. In effect, van der Leeuw is detailing Heidegger's equipmental totality (see Chapter 3).

In Chapter 3 I also discussed the chains of Behavioral Archaeology and the ways in which the choice of materials to make a pot are influenced by downstream knowledge about what the pot will be used for, how long it will be kept for and so on. In Chapter 3 I suggested that the value of Leroi-Gourhan's notion of *tendance* was that it focuses on the interactions and fits between technical acts. There is a tightness to

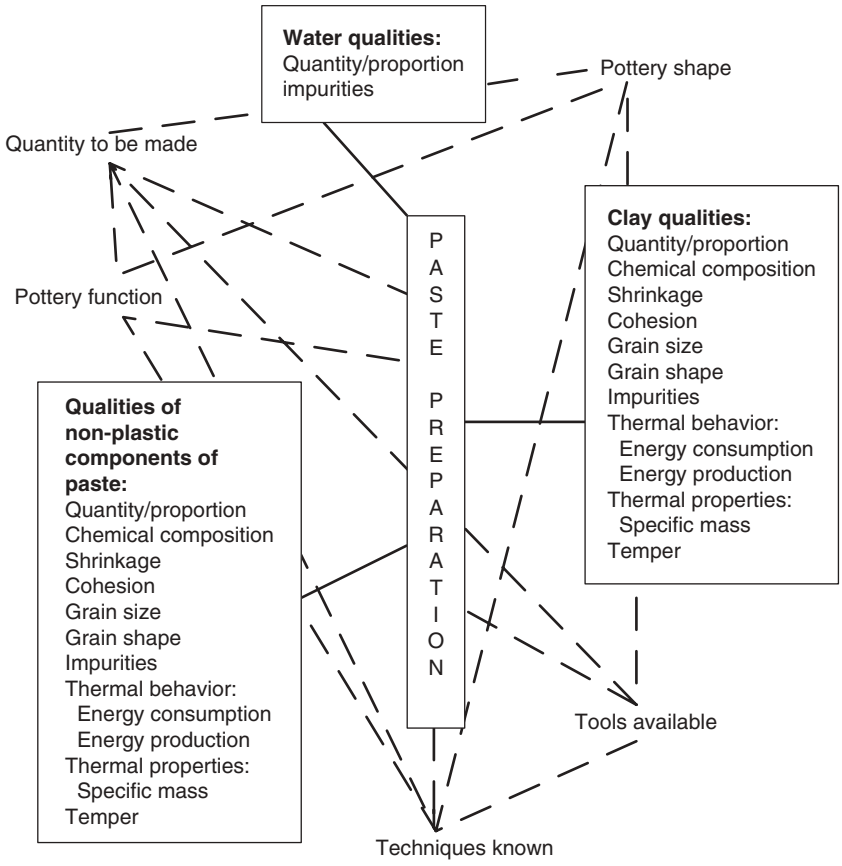


Figure 6.1 Some of the factors involved in one stage in the production of pottery: paste preparation (Source: van der Leeuw 2008: 235). With kind permission from Springer Science+Business Media B.V.

the interactions between things that is in large part produced by the ways in which thing processes have to fit together in sequences but that is also produced by the ways that things have qualities that object, stand in the way, and thus constrain what can be done. Lemonnier (1993a: 13) uses Leroi-Gourhan's idea of 'favorable technical milieu' (*milieu favorable*) to refer to the way novelty finds its place in a technical system. The favorable milieu describes the surrounding conditions which allow a trait to be accepted into a system.

These technical systems in which certain functions are afforded are, as we have seen, nested and embedded (Jones 2004). Sillar and Tite (2000) have used the term 'embedded technologies'. The notion of embeddedness in relation to technology indicates that 'every technique is part of a wider context of artefacts, environments, ideologies, economic systems and social structures' (Sillar 2001: 291). In Chapter 3 I described the three-tiered ordering of technical systems identified by Pierre Lemonnier (1993b and 2012), from the components of a specific technique at the

first level, to the linking of techniques at the second level, to the embedding in wider social and cultural processes at the third level. There are many approaches to studying the embeddedness of technologies in other aspects of society (Latour 1988, Ingold 2000, 2004).

I described some different possible forms of entanglement in Chapter 5 – highly redundant versus highly integrated systems; highly centralized versus highly dispersed. Some entanglements are highly locked in, and others less so. In Chapter 5 I described the factors leading to different degrees of entrapment which might be seen as different degrees of tautness or fittingness in the web. Another distinction that will help us explore the idea of different forms of fittingness is that made by Porter (1996) in his account of operational effectiveness versus strategic positioning in different types of business corporation or company. As companies go about the task of creating, producing, selling and delivering a product or service they may do these tasks better, faster, with fewer inputs and defects than other companies. Their operational effectiveness is greater. Entanglements, technical systems, productive systems are often considered by archaeologists in these terms – that is in terms of their efficiency at minimizing costs and maximizing returns (see Chapter 4).

Porter argues, however, that companies that follow a path based solely on operational effectiveness are less likely to succeed long-term. The reason is that the best practices pursued by a company in achieving operational effectiveness are easily copied and the competitive edge is lost. Porter argues that the companies that have been most successful over recent years have followed a different path, based on what he calls strategic positioning. The emphasis is on developing a distinctive strategy for each company and performing a different assemblage of tasks held together by some special characteristics. The aim is to identify for each company a unique mix of practices and values that all fit together.

At times through this book I have provided anecdotes and examples from my air-travel experiences. Many of my negative interactions with airlines have been with large, monolithic companies that are struggling to cut costs so as to increase operational effectiveness. At the time of writing, the degree of profitability of these companies is decreasing. But Southwest Airlines seems to be doing rather better than most. Porter argues that this is because the company is pursuing strategy rather than simply cutting costs. Certainly the airline is characterized as low-cost, but this attribute is linked in to a broader style or strategy which fits the parts of its activities into a coherent whole (Figure 6.2). Southwest Airlines offers short-haul, low-cost, point-to-point service between midsize cities, and avoids large airports. It has fast turn-around at the gate of only 15 minutes, so it can keep its planes flying longer and have more frequent commuter-like flights. The fast turn-around is partly possible because there are no meals, no assigned seats and no interline baggage checking. Only one type of aircraft, the 737, needs to be used, cutting down maintenance costs.

Porter's main point about the strategy is that it is about fit. Other airlines, including those providing full-service, have imitated some of these practices from

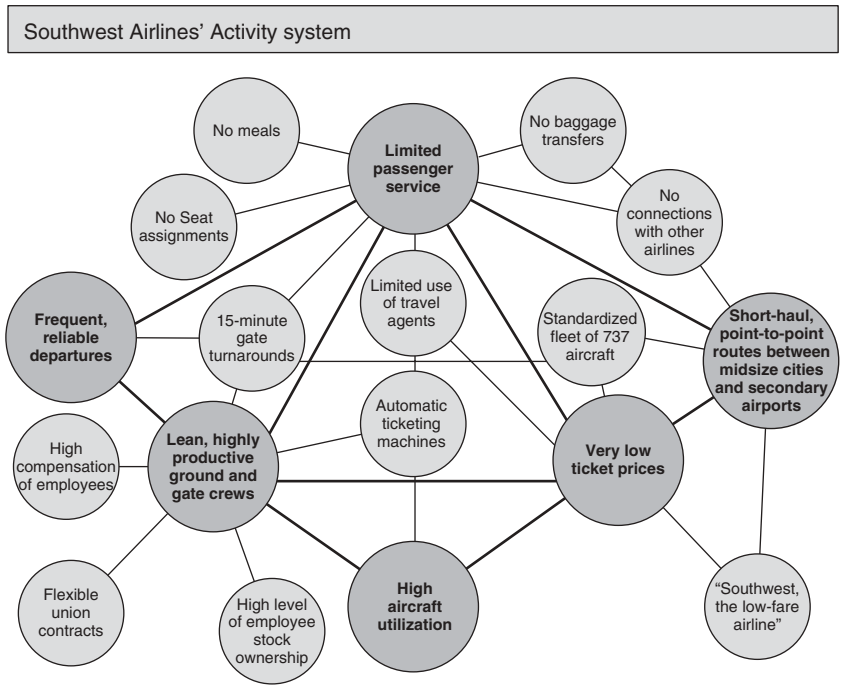

Southwest Airlines' Activity system
No meals
Limited passenger service
No baggage transfers
No Seat assignments
No connections with other airlines
Limited use of travel agents
Frequent, reliable departures
15-minute gate turnarounds
Standardized fleet of 737 aircraft
Short-haul, point-to-point routes between midsize cities and secondary airports
Automatic ticketing machines
High compensation of employees
Lean, highly productive ground and gate crews
Very low ticket prices
Flexible union contracts
High level of employee stock ownership
High aircraft utilization
"Southwest, the low-fare airline"

Figure 6.2 The organization of Southwest Airlines (Source: Porter 1996).

Southwest, but when they have tried the result has often been failure because the practices do not fit other parts of their company. For example, Southwest can avoid airports with congestion that introduces delays. The full-service airlines committed to being able to take anyone to anywhere cannot make such savings. 'Fit locks out imitators by creating a chain that is as strong as its *strongest* link' (Porter 1996: 11). Southwest's activities complement each other to create real economic value.

Porter describes three types of fit. The first-order fit is just the consistency between each activity and the overall strategy, which in the case of Southwest is low-cost, no frills, short-haul. Second-order fit occurs when activities are reinforcing. It is not just that activities are consistent with each other but that the use of only one type of aircraft and the lack of need to get meals on board reinforce the quick turn-around at the gate. Third-order fit is optimization of effort. This involves coordination and information exchange across activities to eliminate redundancy and eliminate waste. Taking these three types of fit together, the focus in strategic positioning is on how the parts fit into a whole and on the competitive advantage of the whole system. In such a system imitating between companies is more difficult as each part has to be linked in to other parts.

Certainly the fittingness that Porter describes affords adaptive fitness in relation to the goal of increasing profit margins, at least for the moment as I write this chapter.

Future competitive pressures, such as the rising price of gas and airline mergers may force additional changes and even possibly put Southwest out of business. There is a nested scale of entanglements within which an adaptive niche is found. But there is also something else. There is a certain coherence to Southwest that crosses domains (types of food, types of ticketing, types of airport, types of flight). The lack of food, lack of assigned seats, avoidance of major airports, avoidance of long-haul flights all add up to a particular style that is very present in other aspects of Southwest's marketing and corporate image.

Coherence: Abstraction, Metaphor, Mimesis and Resonance

The Porter study of companies suggests that the understanding of fittingness is not restricted to questions of how well the parts contribute to the functioning of the whole. Going to Southwest's website one sees that a key marketing image is a love heart, and that the company foregrounds 'gay travel' and its sponsorship of the National Hispanic Cultural Center. Presumably all these activities also contribute to the considerable economic success of the company, but what is the link between a low-cost airline and these activities? We may all recognize some link, but what is it and how would we describe it? When we ask why a love-heart fits in such a context, we are asking why it seems appropriate in some way other than increasing profits – though it may well do that. What is it about love hearts, gay travel and Hispanic culture that make them appropriate or coherent in making profits in this airline?

So far I have focused on the affordances within entanglements – how the parts allow other parts to function in relation to some end. Some of these parts are abstract and conceptual. Presumably the love heart icon, the support of gay travel and Hispanic heritage are all part of an idea that Southwest management thinks appropriate in a company that focuses on being friendly (low cost, quick and efficient) to people, taking care of people, listening to their different and diverse needs. As we saw in previous chapters, entanglements are heterogeneous. They involve ideas and symbols that are seen as fitting. But it may be possible to take a further step. The ideas and symbols may be entangled in themselves, and they may themselves influence the way the practical entanglements take shape. Thus it may be the case that the ideas and symbols in the larger society about diversity and community have led companies such as Southwest to develop a particular low-cost, people-centered strategy.

At the start of this book in Chapters 1 and 2, I noted that thoughts, ideas, sounds, words were also things. Since Chapter 2 I have largely focused on things that are hard material entities. At this juncture we can return to thoughts and ideas as things. In many ways, these types of things have similar properties to material objects. Humans depend on them, invest in them, care for them; they may have legal ownership of them. Ideas and thoughts and words in the form of brain activity or spoken sounds

have temporalities too short to become entangled in human lives. They fade and die out too quickly. But of course when remembered, included in stories or myths, written down, otherwise recorded or memorialized they do come to have a presence that endures, falls apart and requires fixing. We do get entangled in their materialization. But we also get entangled in intangible heritage, however oral or musical it might be. The full suite of ways in which we get entangled in ideas and thoughts is beyond the scope of this volume, but I do wish to point to the fact that we get entangled in abstractions (that organize our thoughts). I also argue that we become entangled in the desire to create various forms of coherence (even if the coherence is dominated by a search for dissonance), both at discursive and bodily non-discursive levels. So in this section I will discuss abstractions, metaphors, mimesis and resonance (bodily coherence across domains) as various forms of production of coherence in which humans can become entangled. This is a different type of entanglement to that discussed in Chapter 5, but it is an important dimension of human-thing dependences.

Abstraction, Metaphor and Mimesis

Southwest is very conscious of its own corporate 'way of life'. A list is given on its website under the heading 'culture' of the desired characteristics of a Southwest person (perseverant, egalitarian, passionate), and these qualities are abstracted into the more general injunctions to be low cost and have high customer service delivery, and the mission statement talks of warmth, friendliness, individual pride and company spirit. So there are clear abstractions here that create a unity and coherence to activities across domains. Throughout this book I have shown how entanglements involve material and conceptual components. In Chapter 2 I described a pebble on a beach that was brought into different assemblies with other things depending on how it was recognized, remembered and owned. In that chapter too I described how the equipmental totality of a thing depended on the different theories about and perspectives towards it. In Chapter 3 I used the quote from Gibson that 'an affordance points both ways, to the environment and to the observer' (1986: 129). In Chapter 4 I noted that the maintenance of walls in the Yorkshire Dales depended on expert ideas about organic foods and recent collective nostalgia for a rural way of life. In Chapter 5 I showed how a sail boat had different entanglements, and different affordances depending on the perspectives of sailing, entertaining and protecting the ecosystem of the bay. These ideas about the boat are themselves tied to wider ideas about what is leisure and how the environment should be protected.

So entanglements and affordances and functions are always tied to abstractions (ideas, thoughts, words, feelings and senses). These abstractions are hierarchical and nested as noted above, and they often cross domains so that humans seek unities, coherence, metaphor within different realms of experience. Abstractions are general and can often be applied to more than one domain of activity. Their transferability

creates a new form of entanglement – one based in ideas, the coherence of logics and philosophies, the use of analogy and metaphor. Tilley (1999) has provided a detailed and persuasive account of how metaphor affects material culture and creates links between different types of artifact and social domain. Thus tombs may be metaphors of houses and landscapes metaphors of social systems. The metaphors are 'solid', grounded in the experiences of material things as they are encountered (Tilley 1999). Ortman has shown that conceptual metaphors linking the decoration of textiles, pottery and kivas in the Great Pueblo period (AD 1060–1280) in the American Southwest were linked metaphorically: 'the Mesa Verde kiva was a metaphorical expression of an earth-bowl and sky-basket cosmos' (Ortman 2000: 638).

In a fascinating account of the cultural and scholarly fluorescence of fin de siècle Vienna, Schorske (1961) explores the intellectual coherence across artistic domains. The work of the late 19th century urban planner Otto Wagner was characterized by rationalism and efficiency, but he also saw man as uncertain in a fast-moving world. Architecture had to provide lines of guidance for movement (as in Wagner's use of Art Nouveau within buildings). Freud at the same time argued for a science of the psyche. 'Freud gave his fellow liberals an a-historical theory of man and society that could make bearable a political world spun out of orbit and beyond control' (Schorske 1961: 103). During the same period the artist Gustav Klimt reacted against classical realism in order to explore inner meaning and repressed suffering in an increasingly complex world, and his paintings are full of symbols influenced by Nietzche and Schopenhauer. In the early 20th century, Arnold Schoenberg created in Vienna the breakthrough into atonal music. Schoenberg knew Freud and Klimt and was aware of the emphasis on social flux and the repression of self. Before Schoenberg all western music was based on the tonic triad. Of course there was dissonance but only to create tension and a return to the main key and triad. Schoenberg wanted to break the established order and rationalism of tonality. He introduced a system in which, rather than some notes having more importance than others, each tone had an equal power. Schoenberg sought the dissolution of boundaries. So according to Schorske, running through all these different artistic domains there was a general idea, a problematic that dealt with the role of the individual in a disintegrating society and a shift from the rational to the psychological. These themes themselves had their context in political movements, in particular the role of liberalism in relation to anti-Semitism, socialism and nationalism.

We can argue on the basis of examples of this type that humans get caught up in the attempt to make links across domains, to create intellectual coherence, to seek metaphor and unity of idea. So humans get entangled in ideas, or rather in making sense and coherence out of ideas. But is it adequate to argue that it is abstractions that produce intellectual coherence? In his book 'The Sense of Order', Gombrich (1979) discusses the writing of Alois Riegl in the late 19th century who had a perceptual theory of style that saw different media unified by general themes. His thesis was that 'the history of art from ancient Egypt to late

antiquity is the history of the shift of the *Kunstwollen* [will to art or will to form] from tactile (Riegl says haptic) to visual or 'optic' modes of perception. The shift can be observed not only in the figurative arts, it also manifests itself in architecture and in the decorative crafts. Every architectural motif, every brooch or fibula of a given period, must and can be shown to obey the same inherent laws of stylistic development that drove art relentlessly from touch to vision' (Gombrich 1979: 196). Thus classical sculpture was more about touch whereas late antique sculpture had deeper drilling, as opposed to the use of chisels, and so was best seen at a distance. Riegl saw the unity of style as resulting from abstract and deep principles, embracing the Hegelian notion of governing spirits. Gombrich is critical of this approach. He asks how the principles of Greek architecture can be transferred to an ordinary pot? Maybe the so-called unity is just the result of force of habit?

By way of contrast, Gombrich discusses the work of Heinrich Wölfflin who again in the late 19th century was critical of a Hegelian view and looked for a more bodily sense of coherence and unity within the visual realm specifically. He argued that 'we respond to shapes much as we respond to music by dancing inwardly' (Gombrich 1979: 201). In his 1888 book 'Renaissance and Baroque', Wölfflin argued that 'there is … a Gothic deportment, with its tense muscles and precise movements; everything is sharp and precisely pointed, there is no relaxation, no flabbiness, a will is expressed everywhere in the most explicit fashion. The Gothic nose is fine and thin. Every massive shape, everything broad and calm has disappeared. The body sublimates itself completely in energy. Figures are slim and extended, and appear as it were to be on tip-toe. The Renaissance, by contrast, evolves the expression of a present state of wellbeing in which the hard frozen forms become loosened and liberated and all is pervaded by vigour….The most immediate formal expression of a chosen form of deportment and movement is by means of costume. We have only to compare a Gothic shoe with a Renaissance one to see that each conveys a completely different way of stepping; the one is narrow and elongated and ends in a long point; the other is broad and comfortable and treads the ground with quiet assurance' (quoted by Gombrich 1979: 202).

Wölfflin recognizes that these general styles are not always mirrors of their time – sometimes architecture can get out of step with the moods of the age; and also there may be technical explanations for certain themes. But Gombrich suggests that Wölfflin was on the right track despite the difficulties. 'We all feel sure that a Rococo ornament would look out of place in an ancient Egyptian temple or a chinoiserie in a Renaissance church' (Gombrich 1979: 203). There is an affinity in *Art Nouveau* between painting and decoration in the use of sinuous lines. But not all buildings and furnishings produced in the period of *Art Nouveau* used the same principles or themes. In fact different media in art at any one time period may play off each other in contrastive ways.

In discussing the Southwest Airlines use of the term 'culture' I placed the word in quotes. The foci on entanglement, affordance and coherence seem to me to

argue against ideas of culture, tradition and repetitive practices or routines as established wholes that somehow determine what we do. They seem to me to argue against any over-emphasis on Bourdieu's (1977) notion of habitus. We often reify these concepts and give them explanatory force; as commentators we get entangled in their logic and reify their presence. Thus we assume that there are cultural ways of doing things, or traditions or routines that all human actors have to work within because it is easier not to upset and change them (Gell 1998: 215, Gosden 2005: 196) or because they have become embodied. Perhaps in some cases these types of argument are needed. But we cannot take these assumptions for granted. Another possibility is that humans are always seeking and searching to find solutions that 'work' in a particular context within a particular strategy. This is more the view of Human Behavioral Ecology as discussed in Chapter 4. If cultural traditions, routinized practices, traditions and styles are found we should initially suppose that they afford something within a particular entanglement. Depending on them and maintaining them may afford humans the ability to achieve some goal. In speaking of what appears to be the logical development of styles, Gombrich (1979) preferred an approach based on K. R. Popper's 'logic of situations' in which one focuses on the courses of action a human might choose in pursuing a particular aim. Crafts-persons or their patrons might want to gain prestige and status by making designs more complex or more simple, or they may have other, financial constraints that lead to a desire for simpler designs. Or those working for Southwest may decide, rightly as it has turned out, that in a particular market certain ideas and abstractions will lead to increased profit margins.

The process of copying or mimesis is often complex, involving the idea that the copy gains some power from the thing copied (Taussig 1993). The problem of 'style' in archaeology has long been debated (Conkey and Hastorf 1990), and I have argued that style is often highly social and active (Hodder 1982, 1986). Stylistic similarity and difference are related to questions such as prestige competition, emulation and group affiliation. We never copy things blindly. As we make, use and reproduce things using routine practices we are at the same time dealing with broader goals and purposes that cross material domains as well as with the specifics of situational logics. Highly active and situational mimetic and transformative processes work within corpuses of objects that have their traditions and ways of doing things. But when we do things socially with artifacts in the specific circumstances we find ourselves in, we are both entangled in what affords our social goals and we are caught up in webs of abstract ideas and metaphors that often cross domains.

The entanglements that humans are caught in are thoroughly material, as argued in Chapter 5, but they are equally laced with abstractions. Humans are entangled in concepts and ideas as they seek pattern and coherence at a higher level that crosses domains. Humans are entangled in things and in their ideas about things. And as one moves up the ladder of abstraction, so different domains of activity get entangled with each other.

Synaesthesia

I also want to argue that there are mechanisms that produce coherence across domains in which intellectual abstraction, metaphor and mimesis play little part. The embodied coherences described by Wölfflin remain tied to intellectual abstractions. I want to argue that there are bodily processes that themselves seek coherence across domains. It seems to me that we understand very little about these mechanisms but I nevertheless wish to argue that they exist and are powerful forces in creating unities and coherences that contribute to entanglements. The two forms of bodily coherence I wish to refer to are synaesthesia and what I will call resonance.

An example of the bodily search for coherence across senses and domains is the process termed synaesthesia. I have often conducted the following task with a large class of students. I show them the two drawings seen in Figure 6.3 and ask them to assign to them the nonsense names *takete* and *maluma* on the basis of what name seems most appropriate for each figure. Over 90% of the students always select *takete* for the angular drawing and *maluma* for the circular one. I got the idea of doing this task from the psychologist Köhler who conducted a controlled experiment of this type that has been replicated many times and at least once cross-linguistically among Lilongwe-speaking children in Tanzania (Berlin 2006). In earlier work Sapir showed his subjects figures of two tables of different sizes, indicating that the nonsense words *mil* and *mal* were the tables' names. He then asked subjects which name indicated the larger table. They invariably chose *mil* for the smaller table and *mal* for the larger (Sapir 1929). On the basis of a general review of such examples, Berlin (2006: 26) gives his own definition: 'synaesthetic sound symbolism can be thought of as the cross-modal mapping that unites specific speech sounds and one or more distinct sense modalities (sight, touch, smell, taste)'.

In general, Berlin (2006) argues that high tones and high-frequency consonants are associated with high-frequency sounds, small size, sharpness, and rapid

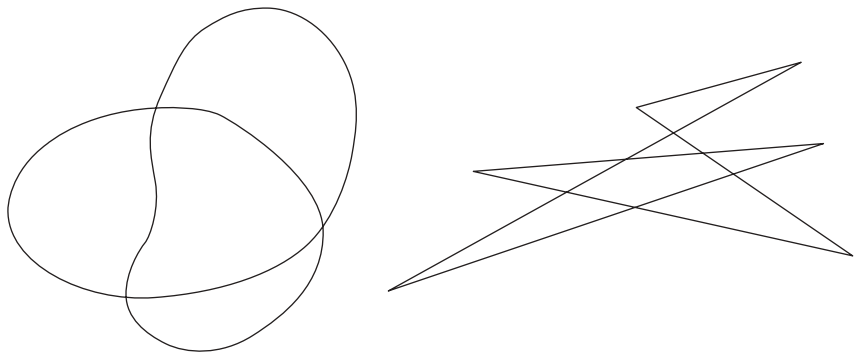


Figure 6.3 Two drawings to which the terms takete and maluma are assigned (Source: the author)

movement; low tones, low vowels and low-frequency consonants are associated with low-frequency sounds, large size, softness, and heavy, slow movements. 'The representation of… lip and tongue movements in [our] motor brain maps may be mapped in non-arbitrary ways to certain sound inflections in auditory regions [of the brain] and the latter, in turn, function as non-arbitrary links to an external object's visual appearance' (Berlin 2006: 39).

Gombrich too discusses synaesthesia. He notes (1979: 287) that colors can be described as warm, sweet, loud or cheerful and sounds can be described as bright, soft, harsh or sad. He reviews the many centuries of thought on the relationship between music and color. In the 18th century the Jesuit P. Castel built a color piano, with the primary colors corresponding to the triad. Synaesthesia can be seen as a normal dimension of experience of the world in which sensory coherence is sought across domains. Shore (1996) argues that synaesthesia is an elementary form of meaning construction linked to analogy and metaphor. He follows Donald (1991) in suggesting that mimetic processes occur prior to language in the evolution of humans and that there is a central mimetic controller that looks for associations across domains and senses. Although there may be a universal component to synaesthesia it seems also possible to argue that cross-domain mimesis simply results from the fact that when we perceive the world we do not use our senses separately – rather we use them simultaneously. 'The information conveyed by one sensory channel is often closely intertwined with that conveyed by another' (Clarke *et al* 2010: 43). Tilley (2004: 14–16) discusses synaesthesia in an archaeological context and describes it as the fusion of the senses. 'Synaesthesia, the overlapping or blending of the senses (seeing sounds, hearing colors), is usually regarded as a peculiar, romantic or even pathological experience … but instead it can be regarded as our primordial preconceptual experience of the world' (Tilley 2004: 14).

Resonance

Recently I was talking to someone who said the following about a liberal, politically left, small college in the United States. 'They are very good on gender politics. It's all very granola-ish.' What is this strange link between a type of food and a political philosophy? What I have argued so far in this chapter is that this type of play on coherence across domains can make use of a range of factors including abstraction, metaphor and mimesis. People get entangled in things, as we saw in previous chapters, but they also seem to get entangled in their thinking about things. I stayed in the house of a 'granola person' recently. The sheets were brown not white, the shower room was tiled in raw stone slate rather than ceramics, and you could hardly move for all the plants.

Of course I am oversimplifying, and many people work between and across such cultural categories, mixing and transforming them into new styles and

anti-styles. But it remains the case that humans often categorize each other using abstractions that cross domains. There may also be some universal basis for this search for cross-domain coherence as indicated by the work on synaesthesia. But archaeologists know that there are no universal meanings for curved as opposed to jagged decoration on pottery. There is too much specific social load that is placed on such distinctions, and interpretations have to be specific and contextual. It remains possible that there is some form of process by which at a non-discursive level coherence occurs across domains in historically specific contexts. It is this specific process that I refer to by the term 'resonance'. What is the non-discursive contextually-specific process of embodiment that makes a person find certain things appropriate across domains such that another person recognizes their behavior as granola-ish?

It might be thought that the answer to this question had already been provided by those working on practice and embodiment. Bourdieu (1984) in his work on 'distinction' in 20th century Paris, shows how different groups in society, partly defined by income and educational level, prefer different types of music, food, furniture and so on. He is less interested in the coherence issue that I focus on here, but he does show how people higher up the social ladder tend to act and think in ways that are influenced by the abstracted notion that they are distant from the material practicalities and necessities of life, and from the material immediacies of everyday existence. They tend to prefer music which is 'difficult' to understand in its intellectual complexity. Across domains, they prefer more complex and time-consuming and elaborate food, and read difficult authors.

Clearly there are material bases for social and cultural difference – whether one can afford the time to learn about and listen to complex music (or afford granola) is part of the realm of affordances discussed earlier. My concern here is to accept these affordances within entanglement and to explore the process of coherence-seeking across domains – the production of general styles of doing things. Bourdieu's work is an important reminder that coherences across domains are to a very large extent dependent on affordances – what can or cannot be done in specific social settings. They depend on the tautness of dependences and affordances within entanglements.

But the question that I have here is rather different. The Parisian elites may have been drawn to difficult music such as Ravel's Piano Concerto for the Left Hand as part of a fascination with forms of experience opposed to the easy and more immediate, including music such as 'The Blue Danube'. 'Easy' music, or music that was 'easy' to listen to were associated with lower classes. So here we are talking about coherence produced by abstractions as discussed above. But it has never been clear to me why the Blue Danube should be seen as easy, popular and for the masses. Why is 'The Blue Danube' seen as 'easy'?

We have seen that Schoenberg introduced 'difficult' atonal music, certainly from within an intellectual elite in late 19th and early 20th century Vienna. But in making sense of this shift Schorske moves beyond the notion that it was just

difficult and associated with elites. He suggests that Schoenberg was dissolving established structures, exploring equalities of tones, creating dissonance – all as part of a general social and political movement of the time.

And yet we have seen that Schorske's approach appears too intellectual. Perhaps the example of music can lead us towards a better understanding of the human search for bodily coherence. I have already quoted the statement from Gombrich that 'we respond to shapes much as we respond to music by dancing inwardly'. What could this possibly mean?

I want to suggest that the example of music, or at least some types of music, may help us to understand a bodily affinity or resonance across domains that is developed contextually. The aim is to use the example of music to see if it might help to understand the bodily process by which granola and brown sheets feel right in a certain social context. The solid metaphors of Tilley (1999) suggest that granola and brown sheets are metaphors of earth and of a particular social approach that is sensitive to the environment and left-wing politics. Again it seems to be some abstract idea here that links grains and earth and brown. My aim in using 19th century music as an example of bodily resonance is that this type of music sought not to use symbolic reference. Its meanings were to work differently.

Let me give an example. In the early 19th century Beethoven started doing something new with classical music. Some would argue that he got it from Mozart, but Beethoven was identified throughout the 19th century as the towering figure that all Western composers sought to emulate and transcend. The something new, the new sound that Beethoven started demanding of pianos in salons and orchestras in large halls came to be called romantic. This 'romantic' is one of these abstractions that cuts across many domains. Romanticism is usually opposed to classical rationalism and is often associated with political liberalism, but there is a great danger in assuming an overall coherence to the term since it is and was used in many different senses and there is no simple link between romanticism and political movements (Dahlhaus 1989). What were the specific things that Beethoven started doing that so changed music and came to be called romantic at the abstract, conscious level?

Beethoven's work is often divided into three periods and it is mainly the third period after 1815 that is most obviously, to us, romantic. This later music had various characteristics including a more lyrical and expressive style. In his later works Beethoven used themes in complex and multi-leveled ways that cut across movements and even whole symphonies. There is an 'element of ever-increasing reflection' (Dahlhaus 1989: 85). Audiences were attracted by the 'feeling' and emotion in Beethoven's music. They were aroused to new individual introspection. They were awakened to nationalistic sentiments by the use of folk songs set in the context of large orchestras and loud resounding music. 'Music that did not reach the heart … was considered meaningless noise' (Dahlhaus 1989: 89).

In the 18th century, music remained very tied to words. Music was seen as secondary to and heightening the significance of words (Cook and Dibben 2001).

Purely instrumental music came to dominance in the later 18th and 19th centuries. Music in these later times often did not represent anything; it was something to contemplate in its own right. In the classical sonata form of the 18th century there is a contrast of themes of different character, an opposition of tonic and dominant, and resolutions of oppositions. Zaslaw (1989) argues that the classical style in music was akin to the classical style in architecture and that the sonata form does for music what the neo-classical façade does for architecture: create order and symmetry, balancing tension and resolution. In romantic music there is more of a focus on tensions and frustrated, incomplete resolutions that lead to more tensions in a series of waves. There is often reference to other 'lost' themes, and a sense of longing, absence, fragment and ruin (which of course takes us across to another domain born of the 19th century – the archaeology and preservation of ruins).

To be more specific about what Beethoven and the romantics did to music, the classical style which they built upon and reacted against was based primarily on the relationship between tonic (first note in an 8-note scale) and dominant (5th note) harmonics. The subdominant is the 5th below the tonic. By moving in a circle of fifths one returns to the starting point in an elegant and mathematical progression (Rosen 1997). The sonata form goes through a simple progression of themes in the tonic and dominant keys. The romantics increasingly disrupted the neat symmetry of this rational structure as they introduced longer melodic lines and complex emotions that broke out into surprising keys and tempos and crescendos. Beethoven explored more the major and minor versions of keys, and used the median and submediant rather than just the tonic, dominant and subdominant. The romantic form was less syntactical and more cumulative in effect (Rosen 1997); increasingly there were so many changes of key that it was difficult to know what key the music was in.

This new form of music had its context. I do not argue that it was part of some cultural 'whole', but I do argue that it was caught up in a series of specific entanglements. An important new context was the shift in the context of music from the 18th century court to the 19th century concert hall. Public concerts did take place in Vienna from the 1770s onwards, but Haydn and Mozart depended very much on aristocratic support. Beethoven obtained support from wealthy aristocrats early in his life but not in his later years. As aristocratic patronage of musicians declined into the 19th century more generally, composers earned money in public and private performances, composition and in teaching and working for the theatre and church (Hanson 1985). There was a huge rise in public concerts as well as an increase of salon music in middle class homes. In Biedermeier Vienna, nearly all middle class houses now had pianos.

Another important context for Beethoven was an idealism born of the French Revolution (Hanson 1985, Ringer 1990). Early romantic music was linked to revolutionary songs sung by the republican masses – such as the Marseillaise sung after the French Revolution. For many (though see the caveat above), romanticism was 'a cultural expression of the spirit of political liberalism' (Samson 1991: 3). Many

composers tried to capture the power of loud marching songs and the republican zeal of folk and nation. National anthems emerged as of importance and folk songs were used in symphonies and in chamber music at home.

This same period at the start of the 19th century in Europe is often seen as a key moment in the rise of individualism (Foucault 1995, Taruskin 2005). The industrial revolution allowed cheap editions of music to be mass produced for the home and for private music. So with one's own mass-produced piano at home one could reach solitude and inwardness. Salon performances by Beethoven or later Schubert or Chopin allowed a domestic display of emotion, intimacy and virtuosity. There was a search for inward-looking sensibilities and subjectivities (Tomlinson 1999).

Another important context at this time was the rise of the bourgeoisie and the decline of elite wealth and privilege. Without aristocratic patronage, musicians had to cater to a broader public – to be popular. There were ticket sales so that larger numbers could now attend the new larger concert halls that were constructed. There were also important technological changes. There were new instruments (violins and pianos) that could play louder and more complex pieces (Taruskin 2005). Change in piano technology in the 18th and 19th centuries led in the 1820s to the American invention of the cast-iron metal frame with hitch-pin plate made in a single forging which was the basis for all later piano manufacture (Grafing *et al.* 1974). As we have seen, things depend on things, and these sturdier frames then allowed the invention in Britain of the use of piano wire made from cast steel. The development of new wires for pianos benefited from the invention of other special wire products such as that used in early telegraphs and in barbed wire.

So at one level, the example of 19th century romantic music allows us to see once again how entanglements between humans and things always involve abstractions that affect many areas of life. The ability to forge iron and the conjunction of the development of telegraphs and barbed wire played their role together with political and social change in a new set of ideas that came to be called romantic and affected many areas of life.

But at another level, the example allows us to probe the links between an area of cultural expression and its wider context. My aim has not been to link romantic music to everything occurring in society at the time. There were many different strands to early 19th century social and cultural life, many more rationalizing and classical than I have been discussing here. But I have wanted to understand the links between romantic music and a particular set of entanglements. Some of the links do indeed seem representational. The tunes of folk songs used in symphonies and in salon music do indicate the folk and the nation very directly; the crescendos produced by large orchestras in which the violins have new steel strings perhaps reproduce the fervor of revolutionary zeal and the cry of the nation.

But there seems more to it than representation and discursive abstraction. Beethoven railed against piano makers, asking them to make louder, bigger pianos. He was very affected by the French Revolution and originally named the Eroica

Third Symphony the Bonaparte before angrily scratching out the name when Napoleon made himself emperor. He was very affected by ideals of equality and freedom. In many ways he lived a romantic life, in poverty and inward reflection because of his deafness, self-consciously living only for his art. He was abrupt and unconventional in his behavior. But as he sat composing he did not represent all this – that was not his music's role. Rather he found chord sequences that thrilled the spine or seemed to create endless unresolved tensions, long melodies that brought tears to the eyes, themes that returned unexpectedly and longingly. Using precise instructions as to how to play their music (for example when to use the piano pedal) romantic composers 'enlarged the role of sound' (Rosen 1995: 40). They stretched and stretched to awaken emotions, self-reflection and national belonging.

There seem to be bodily associations between emotions, sound and the world that bypass representation and conscious thought however much they may be rationally linked to them by observers and participants. We seem able to respond directly to 'dumb' sounds such that we tingle inside, feel sadness, cry, fear. Some of the associations may be at least partly based on universal synaesthetic links – soft quiet sounds associated with sadness and reflection for example. And yet there is something very specific about Western music of the early 19th century. It does not sound like or work like earlier music or like Chinese music of the same time period. Beethoven's music plays with a particular tradition in very particular ways.

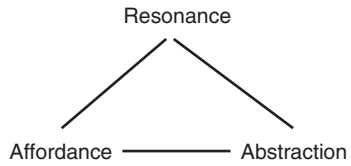
In trying to understand these connections that are made within the body, linked to but separate from abstractions, we need to know more about how the human nervous system works. In general terms, recent work on mirror neurons suggests that we empathize with others and with things through embodied simulation (Freedberg and Gallese 2007). The actions and sensations we see around us activate our own internal representations as if we were experiencing a similar emotion or sensation. Thus if we see pictures of a hand reaching to grasp an object, the motor representation of grasping is activated in our own brain. 'The observation of static graspable objects activates not only visual areas of the brain but also motor areas that control object-related actions such as grasping' (Freedberg and Gallese 2007: 200). Or 'when we see two objects touching each other, our somatosensory cortices are activated as if our body were subject to tactile stimulation' (Freedberg and Gallese 2007: 201). There is thus neuroscientific research that supports Merleau-Ponty's (1962) view that paintings or sculptures arouse a sense of physical involvement, or Wölfflin's notion that observation of specific architectural forms engages the onlooker's bodily responses (see above), or Gombrich's description of inward dancing.

Becker (2001) seeks to understand music as both cultural and biological. She uses the idea of 'structural coupling' to argue that we internalize and externalize our musical sensitivities. '"Structural coupling" describes the internal, structural changes that occur within an organism as a result of interaction with other organisms and with a world; changes of one's being or one's ontology' (Becker 2001: 136). So the music maker and the music listener are engaged in flows of interaction

with each other and with the world such that biology and culture align themselves to each other. In the case of music a key player may be the cerebellum. Levitin (2006: 178) suggests there may be 'a plausible connection among the cerebellum, timing, music, and emotion'. Many parts of the brain are involved in perceiving and liking and responding to music, but the cerebellum seems to play a significant role. Many of the functions of the cerebellum are preconscious and involve coordinating things like running, walking, grasping and reaching – music seems linked to these functions in some way. Intense musical emotions – the thrills and chills of music – are also associated with brain regions linked to reward, motivation and arousal, such as the ventral striatum (Levitin 2006: 179). Neuroscience shows that there is a link between movement, the brain, and music (Levitin 2006: 210). The pathways from the brain stem and cerebellum to the frontal lobes can weave all sensory experience and coordinated muscular movements into a homogeneous fabric. According to Clarke *et al.* (2010: 101) ' music creates a direct sense of virtual movement' as the listener hears in sounds the movements of the performers and the composer.

So as Beethoven sat at the piano he was plausibly involved in a process that explored deep emotions aroused by the complex entanglements he found himself in. These were not the only entanglements prevalent in the years around 1800, but they were the ones that Beethoven responded to and interacted with – revolution, individual freedom, nationalism. There were also other aspects of the entanglement of the time that played a role – new technologies for casting iron and making wires, large concert halls, new bourgeois buying power and so on. Within the musical corpus that was handed down to him he imitated but also transformed and manipulated into new sounds. In exploring sound he was exploring new emotions. As he moved his hands over the piano there was a new freedom in what he did, a new explosion of anger, and new movement towards sadness or reflection. It all resonated deep inside him. The movement and the emotion and the music all seemed to work together with the world in which he found himself and with his passions and frustrations about it. The new bigger and louder pianos he played on allowed him to find these emotions inside himself. He did not just impose his abstract ideas on the music. The piano awakened new potentials in his body that resonated with the world.

And those that listened to his music found something aroused in them also. Those in similar entanglements to Beethoven found that his music resonated but also awakened. They, brought up in and living in similar worlds, found their spines tingle and their sadness deepen. They came to feel themselves in new and different ways. Beethoven, other composers and artists can be said to have produced individualism and nationalism as much as they responded to it. Gombrich may have been right that we dance inwardly when we respond to music and to shapes – and to the world around us. Music can in its rhythms and melodies and chord sequences produce bodies that seem fitting in particular contexts of entanglement and abstraction. Granola and brown sheets resonate



with each other in the sense that at a non-conscious level they contribute to the production of a body attuned to a particular environment.

Music is produced that resonates through the body with the world around it. As well as these non-discursive resonances there are also discursive abstractions produced that cohere with the world around them. These abstractions can 'seem right', 'feel right' based on the objective evidence of one's own body. A human feels, senses, knows in herself that the atomized individual or the patriotic nation are 'true'. One has the evidence of the tingles and chills, the calm, tears and sadness that well up inside one's body as the music is played.

Much the same can be said of all things that humans produce. These resonate through our bodily interaction with them in the world. They come to 'feel right' in particular contexts. Or else we reject them because they cannot be made to cohere, either through abstraction or bodily resonance. Conscious abstraction and bodily coherence work with affordances to produce a particular way of being entangled, in which humans have bodies of a particular kind and things have forms of particular kinds.

Coherence and Resonance at Çatalhöyük

After this musical interlude I want to return to provide an example of how this type of thinking can be applied to the archaeological context of Çatalhöyük. Here I want to look at the relationships between affordances and the two types of coherence I have identified: resonance and abstraction. I suggested in Chapter 4 that humans at Çatalhöyük recruited the ancestors to help hold up the unruly walls of their houses. In one instance they placed a human skull at the base of one of the support posts. In 2009 we made an interesting discovery at the site. By a small protruding platform (or 'capital') at the top of a post in Building 79 we found a human skull (Eddisford 2009). This skull may have been dislodged from elsewhere in the collapse of the building, but the close association with the top of the post invited the interpretation that the skull had been placed on the platform at the top of the post. Perhaps the posts were seen symbolically as ancestors, as clearly were the upright stones with human arms and belts at the earlier site of Göbekli in south-eastern Turkey (Schmidt 2006). Whether this interpretation of the Building 79 skull is correct or not, the skull placed at the base of the post in Building 6 suggests that one role of ancestor skulls was to help support the posts and walls of houses.

Another role of the skull was to create long-term relationships through time. In early agricultural societies a key concern was to build relationships between people that held together in the delay between the input of labor and the receipt of some return for that labor (in the form of harvested crops and meat from domesticated animals). Some version of skull manipulation occurs as early as the Natufian in the Southern Levant. I have argued that from very early in the intensification of plant and animal use in the late Epi-Palaeolothic and Natufian in the Middle East houses are built on houses and on previous burials in order to create ancestry and lineage (Hodder 2007a). All of this afforded the possibility of long-term delayed agricultural systems. The dead were placed fleshed beneath the floors of the houses at Çatalhöyük, and the houses with many (up to 62) burials beneath the floors can be termed 'history houses' (Hodder and Pels 2010). Only a few burials in the history houses were then revisited and the heads removed.

But what made skulls and burials and houses appropriate modes of achieving this adaptive affordance of creating duration at Çatalhöyük? There were abstractions about skull use across the Middle East in the millennia leading up to the occupation at the site. Removal of skulls was widespread in the PPNA and PPNB (Kuijt 2008a, Verhoeven 2002) and there are many known cases of plastering of skulls to create facial features as is found in one case at Çatalhöyük (Bonogofsky 2005, Kuijt 2008a, Verhoeven 2002). The functions of these severed heads probably varied across space and time (Testart 2008; Hodder 2009) but there are some widespread similarities in the ideas with which they are associated. At Çatalhöyük, wall paintings show headless bodies with vultures. At Göbekli a pillar is engraved with a headless body associated with a bird. Stones engraved with vulture images like those at Çatalhöyük occur at Jerf el Ahmar (Stordeur *et al.* 2000). A relationship between birds and human heads is also seen at Neval? Çori in southeastern Turkey (Hauptmann and Schmidt 2007: 67–8).

So practices and ideas about head removal, plastering of human skulls and an association between head removal and birds were widespread throughout the Neolithic of the Middle East and Turkey over millennia. These ideas were drawn on at Çatalhöyük. Were they just repeated practices or were conscious abstractions also involved? It is clear that the latter were involved to some degree. The representation of these practices and abstractions in paintings and engravings suggests that at some level narratives, and perhaps myths, were associated. Conscious re-enactment of head removal is also seen at Çatalhöyük where figurines often have dowel holes for the insertion and removal of heads – and again the figurine heads are sometimes found separately (Meskell *et al.* 2008).

We can see that these abstractions crossed over into other areas of life at Çatalhöyük, and indeed throughout the Neolithic of the Middle East. Already at Hallan Çemi in Turkey in the 11th millennium BC there is an aurochs skull on a wall of a 'public building' (Rosenberg 2007) and by the time of the PPNA and PPNB there is widespread use of bucrania, animal skulls and horns (Hodder and Meskell 2011). At Çatalhöyük these animals skulls are often plastered to recreate

Figure 6.4 Decorated face pot from Çatalhöyük (Source: Çatalhöyük Research Project and Jason Quinlan).

facial features and are installed on walls or pedestals. A conscious metaphorical link is made between human and bull heads in the decoration of the pot shown in Figure 6.4. There are bull heads on the two sides of the pot and human heads at the two ends. In addition at Çatalhöyük both human and animals heads are plastered.

So we can see that people in the Neolithic in the Middle East, and specifically at Çatalhöyük, were caught up in ideas and metaphors that crossed distances and domains. We can also argue that bodily resonance was involved. As the heads were carefully removed from human bodies, the cutting and lifting would have recalled the cutting and lifting of heads of animals. As plaster was smeared over the human skull, so the similar movements and practices of smearing plaster on animal skulls would have been recalled. It is further possible that the plastering of interior house walls and the plaster floors above burials would have resonated with the refleshing of human and animal heads (Hodder and Meskell 2011). All of these replasterings produced a particular type of body and person – one that could be refleshed to live again and one that could be divided up and passed between people. So humans became stretched out over time. Most of us today find the burial practices at Çatalhöyük offensive; it seems deeply unpleasant to live centimeters above decaying flesh and to live in the smells of decaying bodies and to divide up human bodies and pass them around. To our bodies, produced in part by the romantic individualism of Beethoven's time but since then further nurtured into a sacred holism, the Çatalhöyük practices seem wrenching and disgusting. But ethnographic cases are known (e.g. Firth 1936) in which humans live close to the dead and may even value the odors of the ancestors on them.

At Çatalhöyük there were abstractions that circulated, probably as myths. These abstractions got tangled up in themselves as people built metaphors across domains. Different areas of life were made coherent through transfers of ideas. Some of the cross-domain coherence was also produced by a bodily resonance that gave a biological certainty to the abstractions. Produced in the specific context of delayed returns for labor and long-term associations that endured beyond individual lives, these new bodies 'felt right' and underpinned the abstractions they resonated with. The treatment of the dead and the plastering of human and animals skulls produced a certain type of person – one that could be divided up and dispersed; one that could endure through time; one that, in contrast to Beethoven's sensitized individualism, valued the social and the collective as primary.

Conclusion

The tautness of the entangled web of humans and things is produced by various forms of dependence and co-dependency as discussed in Chapters 2 to 5. In this chapter I have argued that an additional form of tautness in entanglements is produced by the human tendency to seek coherence. I have not wanted to argue that humans become entrapped in something called 'culture' or the 'social whole'. I have tried to avoid these reified and difficult terms. I do not argue that there are cultural wholes or cultural traditions that determine entanglement. The fittingness of entanglements is the product of affordances but also the product of concepts and ideas as we have seen in previous chapters. Humans have a tendency

to seek coherences in this conceptual realm and in its relationships to affordances. They do this in two broad ways – abstraction and bodily coherence. Humans thus become entangled in various forms of fittingness, including affordances, abstractions and resonances.

A final case-study will serve to exemplify the argument in this chapter, taken from research of enormous scope. In his account of the relationship between sweetness and power, Sidney Mintz (1985) lays bare the entanglements of sugar. As the demand for sugar in Europe increased through the 18th and especially the 19th centuries, Europe and the Caribbean became 'interlocked' (Mintz 1985: xvi) in the circulation of ships, slaves, sugar. The production of sugar from sugar cane in the Caribbean proved difficult and it was necessary to introduce an industrial organization of field labor from early on in the Caribbean involving boiling houses and mills. Through time there was an increased cycle of colony seizure, plantation, slave import, ship building and sugar import leading to heightened consumption in Europe in the 19th century. Sugar had lots of uses and functions, all interlinked: medicine, spice/condiment, decoration, sweetener, preservative. There were entanglements of sugar with tea, coffee and chocolate. A cup of tea in Europe mixed sugar from the Caribbean with tea from huge estates in India. The sugar trade involved planters, bankers, slavers, shippers, refiners, grocers and government regulators. Legislation was introduced in Britain to regulate purity and quality standards.

So the entanglements of sugar were far flung and highly complex. Humans (slaves) and things (machines) afforded a massive increase in global sugar consumption. As sugar became cheaper and more available it also became linked to changes in abstractions and practices. The organization of the meal sequence during the day changed in Europe, with the consumption of sugar-rich foods consumed in 10-minute breaks in factories, away from home. But there was also the establishment of high tea in the front room of the house. Globally 'refined sugar … became a symbol of the modern and industrial' (Mintz 1985: 193). In the house it became associated with new meal practices, themselves associated with refined gentility and social display.

The resonances of sugar are related to bodily desire perhaps partly because sugar is high in calories. Mintz suggests that sugar satisfies a possibly universal desire for sweetness, but 'it also seems, in so doing, to awaken that desire anew' (Mintz 1985: xxv). Mintz (1985: 136–7) argues that the English already had a sweet tooth before the widespread availability of sugar from the Caribbean. They made mead from honey, and even added sugar to wine to make a candied wine. As sugar became more available they added it to tea, coffee, chocolate and to puddings, jams and cakes. Thus the sweetness of sugar resonated especially strongly in England, stoking the demand for yet more production and trade. Sugar also became associated with particular 'sweet' foods, drinks and occasions. It allowed new sorts of relationships, whether labor relations in the factory or social entertaining in the front room. One of the most famous descriptions of resonance

is provided by Proust (1981) in his account of Swann eating a 'petite Madeleine' cake. As the cake is dunked in tea and placed on the tongue, memories and feelings regarding taking tea with his mother are opened up. There is a bodily reaction to the sweet cake and tea that draws in feelings, memories and emotions. In France as in England a sweet-seeking human body had been produced.

We see in this example the tight skein of humans and things that are caught up in sugar. All the different components are heterogeneous but they are at the same time seamlessly linked together so that it is difficult to separate them. I have tried in this chapter to define affordance, abstraction and resonance as different dimensions of entanglement. I identified them, however partially and inadequately amongst all the muddled business of entanglement, because they are dimensions that lead the different parts to be fitting in relation to each other. Sugar comes into a context in England and it reinforces a certain way of doing things; and through time this way is transformed. There is always a way and a style to entanglement, and bodies and things of particular types are produced.

The notion of fittingness is thus much broader than that of fitness. As we shall see in the next chapter, fitness is often described in evolutionary studies as reproductive fitness, which can be measured in a number of ways such as survival, or survival of offspring, or of offspring's offspring. Proxies of fitness are also often used such as efficiency in resource acquisition. I have argued here that traits may be adopted because they are fitting within a system of affordances. These systems may include the affordance of survival. But it is also clear that traits may be adopted because they cohere within abstractions and resonances.

Fittingness may itself afford reproductive fitness but whether it does or not is a matter of investigation rather than assumption. As was noted above, certain aspects of abstract coherence may get out of step with other aspects of entanglements. Cohering to norms is often not the best strategy; cheating or opposing or foot-dragging may work equally well or better in terms of individual survival.

One of the unfortunate results of the splits within the social sciences and archaeology between those studying culture and those studying adaptation and evolution has been that style has been studied as a complex phenomenon by the former and affordance as a complex phenomenon by the latter. Despite recent attempts to break down this divide (e.g. Knappett 2005, Jones 2004, Shennan 2003) in archaeology, it remains the case that culture, meaning, representation and style are often seen as forming a domain separate from the nitty-gritty of biological survival and the tools needed to achieve it. I have argued in this chapter that our bodies become ontologically transformed, through processes that seek bodily resonances between abstractions and affordances. Cultural abstractions and adaptive processes are thoroughly and seamlessly combined. In the following chapter I will try and develop an approach to the evolution of things that similarly draws on both sides of the debate and uses as a key theme the fittingness of entanglements.

Chapter 7

The Evolution and Persistence of Things

Still sitting in the plane on the tarmac. The plane has a fault and people are inconvenienced (or worse). But beyond this banal fact is the question of how many times faults and delays have to occur before people stop using this company, or type of plane or plane part. Plane parts get selected for if they are fitting in relation to the goal of the plane and the other plane parts, but humans often show great tolerance of inefficiency and failure. Plane travelers put up with a lot of inconvenience. This is at least partly because the alternatives are limited. But if someone could come up with a better plane or plane parts so that there were fewer faults then presumably these new planes would be preferred. But the adoption of a new plane type depends on so many factors. I remembered back to the examples provided by Pierre Lemonnier (1989) of planes with odd shapes were not adopted even though they worked very efficiently. No-one felt safe flying in planes that looked odd.

It is the claim of this chapter that entanglement and fittingness offer an alternative systematic approach for the study of the evolution of humans and things. Existing approaches have often tried to understand the evolution of cultural traits within a biological and neo-Darwinian perspective. But most things are not selected for on the basis solely of reproductive fitness, adaptive resource acquisition or replicative success in transmission. Rather they are selected for because they are fitting within a taut web of entanglements. The reason, returning to my example in Chapter 1, that the piano is not found in a Mesolithic camp site is that the piano needed a whole entanglement involving barbed wire and telegraphs, cast iron and an industrial scale of production, but also a type of music attuned to nationalism, individualism and concepts of the romantic. None of this was even remotely available in the Mesolithic. It is true that a piano in the Mesolithic would not have led to reproductive or adaptive success, and it could not have been replicated, but

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the reasons for these failures are to be found in the fittingness of entanglements. Reproductive and replicative success may play only small parts in these entanglements.

A similar case can be made for other examples I have used in this book: the watch, the wheel, the bicycle, the sail boat. The wheel could not enhance reproductive or replicative success in pre-Columbian America because it was not entangled there with the draughting capacities of cattle and horse. It is the fittingness within entanglements that determines whether a trait is selected for or not. The long-term persistence of wheels has had very little to do with the reproductive success of the people who made and used wheels; but it has had a lot to do with the long-term persistence of domestic cattle and horse, the construction of roads, international trade in rubber to make tires, the invention of the internal combustion engine, and all the multitude of associated entanglements across millennia.

So why should we explore evolutionary theory at all? One reason is that it takes seriously long-term change. We have seen that entanglements incorporate many temporalities, many stretchings out over much longer spans of time than are dealt with in most social, cultural and economic theory. Another reason is that most of the theories discussed in Chapter 2 that have dominated the social and humanistic sciences over recent decades, are very human centered: they deal with agency, meaning, phenomenology, self and personhood. As a counter-balance there is a need to explore theories that are less human centered. Evolutionary archaeologists such as Dunnell (1980) 'asked what the operation of evolutionary forces would look like from the point of view of the cultural attributes or artifacts themselves' (Shennan 2008: 78). While Latour and Actor Network Theory provide a counterpoint to human-centered approaches, we saw in Chapter 5 that they do not deal well with the long term. Darwinian evolutionary theory when applied to cultural change very clearly de-centers the human. But the main and third reason for exploring evolutionary theory in this chapter derives from this book's focus on entanglement. If entanglement consists of a taut set of dependences, abstractions and resonances amongst humans and things, then the adoption and persistence of traits depend on how the traits are fitting within the entanglement. Darwinian theory provides a potential source of ideas about variation, adaptation, selection and persistence that might be applied to the study of change within entanglements.

Evolutionary Approaches

According to Boone and Smith (1998) natural selection has three conditions: variation, inheritance (transmission) and differential fitness leading to selection (see also Mesoudi and O'Brien 2009). A fuller account of the evolutionary process has the following components: (1) genetic variation is continually produced by mutation

and recombination; (2) this variation interacts with external environmental factors to shape phenotypes; (3) these phenotypes and associated genotypes are differentially successful in surviving and reproducing; (4) offspring inherit (some of) the genes and thus tend to develop the associated phenotypes of their parents; (5) the proliferation of more successful genotypes results in transgenerational increase in phenotypes that are better adapted to local environments (Boone and Smith 1998: S142). Four approaches that use aspects of such a framework in relation to the cultural realm and that will be discussed here are evolutionary ecology (HBE), evolutionary archaeology, dual inheritance theory and niche construction theory.

But before exploring these different approaches to see whether they provide a framework for studying the evolution and persistence of traits within entanglements, it may be helpful to make some general points about how cultural and material things are construed within them. For many writers using evolutionary approaches, material culture is seen as part of the phenotype. In biology the phenotype, as opposed to the genotype, is what an organism looks like as a consequence of the interaction of its genotype and the environment. It is the observable characteristics of an organism as determined by both genetic makeup and environmental influences. Cultural traits can be considered as part of the phenotype – extensions of bodily interaction with the environment. But of course, the artifacts are also part of the environment. Artifacts in the environment – boats, cars, watches and pianos – constitute part of the environment within which adaptation and selection occur. For example, it has been argued that the evolution of the ability to make tools changed the environment such that human hands and minds developed in particular ways (Deacon 1997).

So things, like genes, play a double role as part of the phenotype and part of the environment. Another general starting point that might be helpful is a distinction between reproductive success and replicative success. One can clearly argue that a cultural trait is the hard part of the phenotype – like the bird's nest. These phenotypic traits are selected for because they enhance reproductive fitness – which can itself be measured in a number of ways such as survival, or survival of offspring, or of offspring's offspring. In the socio-cultural realm, Hughes (1986) and Voland (1990) have used parish records to show that occupational status (whether a person is a farmer or a craftsman in historic Europe for example) and income have a long-term effect on number of offspring.

Alternatively Darwin can be used in a broader sense to describe replicative success. Cultural and material traits are selected for and they become more common because of the emulation of high status or successful people or for some other reason. There is no necessary assumption that replicative success is linked to reproductive success of the carriers of the traits. Rather the traits themselves are successful. This is an attractive approach in that much cultural change is very fast, too fast to have been the product of reproductive success (Shennan 2003).

Having made these general points, I wish to start by examining the first three approaches identified above as applying Darwinian theories to the evolution and persistence of cultural traits.

Evolutionary Ecology (HBE)

The first, evolutionary ecology, or Human Behavioral Ecology was discussed in Chapter 4. According to Boone and Smith (1998: S141) this 'explains cultural and behavioral change as forms of phenotypic adaptation to varying social and ecological conditions, using the assumption that natural selection has designed organisms to respond to local conditions in fitness-enhancing ways.' Plasticity in adaptation to the environment is seen as having a causal role in phenotypic variation. There is less focus on heritability. Behavioral plasticity allows more speedy adaptation of organisms to environmental perturbations, and that is why it has evolved. Shennan (2003: 171) gives the example of the decline of the plough, wheel and domestic animals in late pre-modern Japan. A cost-benefit analysis showed that the mountainous landscape and the very high population meant that human labor was cheaper than animals and ploughs. As another example, the diet-breadth model discussed in Chapter 4 argues that humans will exploit those resources which have the highest rate of return – and that humans will go down the ladder to lower rates when pressures on resources increase. Boone and Smith (1998) give the example of the snowmobiles used in the subarctic by the Cree, in contrast to those people still using snowshoes. Boone and Smith argue that the snowmobiles spread simply because the Cree individuals could see that snowmobiles were more efficient. In fact with the introduction of the snowmobiles the Cree had a narrower diet because it became efficient to concentrate on higher ranked resources, in concordance with the optimizing diet breadth model.

In Chapter 4 I discussed the importance and value of this type of research into the mechanics of how things and humans work in relation to each other. I also suggested that the focus on optimization could be expanded to include evaluation of how well a trait contributed to the workings of other parts of the entanglement (not only concentrating on resource acquisition and reproductive success). These same points are relevant here again to the study of change and adoption of traits. The approach often focuses on individual objects, disconnected and disentangled except in terms of resource acquisition, signaling behavior or reproductive success. In the case of the snowmobile, it seems obvious that the Cree may use snowmobiles because they make hunting more efficient. Whether groups do or do not use snowmobiles is related to many other factors the authors do not consider. How did these hunters get snowmobiles? How did they get the wages and income to buy/rent them? The costs and benefits of the snowmobiles depend on the larger picture of how people worked to get the money, get loans, make investments, etc. And how do they get the gas and oil to run the snowmobiles? The hunters must be linked to supply pipelines or trucks and roads and international markets. And who fixes the smowmobile? How many parts does it have and where do they come from? Whether there is increased use of snowmobiles depends very marginally on hunting efficiency and much more on these wider entanglements. The ability to concentrate on higher ranked resources and a narrower diet was entangled within

a broader set of affordances and coherences. It would not seem difficult to carry out a rigorous and systematic study of the trade-offs involved in all the entanglement costs of using a snowmobile.

The persuasive and interesting work of O'Connell (2006) suggests how modern humans displaced Neanderthals. He argues that Neanderthals and modern humans in Europe appear to have been distinguished by differences in diet breadth, Neanderthals focusing on relatively high-ranked prey, moderns exploiting a broader, more expensive range of resources. This difference may have allowed moderns to replace Neanderthals by competitive exclusion. Similar arguments can be made regarding the success of early farming populations as they spread across Europe (Shennan 2008), although again the costs and benefits of farming involved much more than resource acquisition at a particular settlement itself; there were also very many other costs associated with making new types of tools (groundstone axes and ceramic containers for example), becoming more involved in long distance trade, and all the costs of maintaining long-term social relationships as we have seen at Çatalhöyük. Aunger (2009) argues that HBE tends to focus on subsistence-level societies and does not deal well, in its focus on plasticity, with larger-scale infrastructures and networks (see the discussion of macro-evolutionary theory in Chapter 8).

Evolutionary Archaeology

If evolutionary ecology and HBE approaches focus on immediate plastic responses to environments by knowledgeable actors, evolutionary archaeology concentrates more on history and heritability. Researchers such as Dunnell (1980), Lyman and O'Brien (1998) are interested in building cultural lineages and then asking how evolutionary processes produced the lineage patterns. Evolution is seen as the result of natural selection, genetic drift, or both. The branching, diverging and converging of the lineage tree can be explained in terms of adaptiveness or drift. 'Our view is that things found in the archaeological record – projectile points, ceramic pots, and the like – were once part of human phenotypes and were therefore shaped by the same evolutionary processes that shape somatic characters. This makes artifacts part and parcel of any discussion of human phylogeny. Tools do not breed, but tool makers *do* breed, and they *do* transmit information to other tool makers, irrespective of whether those other tool makers are lineal descendants. Cultural transmission is a different kind of transmission than what is produced intergenerationally by genes, but this is irrelevant as far as phylogeny is concerned' (O'Brien & Lyman 2000). This type of focus has long existed in archaeology. In the late 19th century, Pitt-Rivers ([1875] 1906) often couched his study of branches on the evolutionary trees of material culture styles and language in Darwinian terms. 'The principles of variation and natural selection have established a bond of union between the physical and culture sciences which can never be broken' (Pitt-Rivers [1875] 1906: 24).

Returning to the snowmobile example, Lyman and O'Brien (1998) argue that adaptive decision making does play a role in the adoption and persistence of this trait but they suggest that the ultimate reason snowmobiles replaced snowshoes is that those that inherited the trait outcompeted those that did not, enhancing both their reproductive success and the replicative success of the snowmobiles. Such claims about reproductive success are often difficult to substantiate. In the study of parish records, as already mentioned, it has proved possible to demonstrate convincingly that wealth or occupation of an individual/family at time t, correlates with having more descendants at time t+1,2…n (Hughes 1986, Voland 1990). But in archaeology it is rarely possible to follow genetic lines of this sort. In any case, recent work (e.g. Jones 2009) has argued that with regard to fitness, survival (or somatic success) is what matters, not reproduction (or reproductive success). Jones shows that there is strong selective pressure on surviving to beyond age 5 (or so). Entanglement provides a way of exploring the material and social factors (such as social support, status, etc.) that may enhance efforts by parents to raise children successfully. It seems, then, that measuring reproductive success in archaeology is not only difficult but also insufficient, as the selective pressures leading to reproductive success and survival are largely to be found in human-thing entanglements.

O'Brien, Darwent and Lyman (2001) apply a cladistics approach to Palaeoindian projectile point types such as Clovis, in the southeastern United States. They define a series of characters (such as base shape) and character states (such as arc-shaped and triangular base shapes) to produce a tree diagram of branching types from ancestors. All of these character states or variables would be entangled with technologies, hunting efficiencies, competitive social prestige. The location of maximum blade width, base shape, outer tang angle, tang-tip shape, fluting, and various length/width ratios are all entangled in hunting and prestige efficiencies. Exploring these wider entanglements, using the approaches described within evolutionary ecology or HBE, would be appropriate in understanding the selective factors that led to the success of the carriers of these points or the replicative success of the points themselves. But the angle that is provided by evolutionary archaeology that is important is temporal continuity – the lineages of ways of doing things. The variants that are present at time t have partly to be understood in relation to the pool of variation available in time t-1.

Evolutionary archaeology understands these continuities of tradition as 'transmission': the curves and branches of lineages of traits derive from the processes of transmission. As Shennan (2008: 80) notes 'clearly, transmission implies continuity but continuity does not necessarily imply transmission.' Shennan argues that continuity can also be the result of drift or the product of a constant environment or function. A constant environment or function plays a similar role to continuities produced by the tautness of entanglement – the entrapment that I described in Chapter 5. If humans and things are situated within complex webs of various degrees of tautness, the web itself limits what can be done. Evolutionary ecology

has a history held together by the entanglement of humans and things. It is true that archaeologists repeatedly identify increases and decreases in the presence of cultural traits through time (the battle-ship curves) but these changes through time can be the product of the direction and gradual transformation of entanglements, as will be explored in Chapter 8.

As I argued in Chapter 6, entanglements include abstractions and ideas that cross domains and get caught up in themselves, their internal rules and logics. I also argued that bodily human-thing resonances can have the same effect of entangling different domains of cultural behavior together. These linked ways of doing things co-evolve through time and evolutionary archaeology is of value in describing this process. Riede (2009) discusses the co-evolution of linked artifacts and searches for co-phylogenetic patterns that might emerge. The example used by Riede is the co-evolution of knives and forks in European table ware from the 16th to the 20th centuries. He ends up with a 'tanglegram' that incorporates the two cladograms for knives and forks. A lot more would have to be done here to situate this tangle of two types through time into the wider entanglements of table etiquette, foodways, class, industrial production and international trade.

Dual Inheritance Theory

We will see that comments related to those made above can be applied to Dual Inheritance Theory (Boyd and Richerson 1985, Shennan 2008, 2009). As many have argued, cultural and biological transmission differ, and there has been much discussion in archaeology of cultural variants (a term used by Richerson and Boyd 2005 and by Schiffer 1999) and of Dawkins' memes. In Dual Inheritance Theory, Boyd and Richerson, and archaeologists such as Stephen Shennan, focus on cultural transmission and argue again that 'some cultural variants persist and spread because they cause their bearers to be more likely to survive and be imitated' (Richerson and Boyd 2005: 238). A cultural complex exists 'because the beliefs of one generation are learned by the next' (Richerson and Boyd 2005: 3). Throughout, Boyd and Richerson (1985) define culture as information held in the brain, though also stored in writing or in pottery decoration. They describe various forces leading to the evolution of transmitted traits, such as cultural mutation and drift, guided variation and biased transmission. In terms of biased transmission there is a results bias that occurs when people change what they do because a new way of doing seems more effective, or a context bias that occurs when the person copied is prestigious or when people conform to local traditions. Indirect bias involves imitation of the most successful role model and sticking to that model. Guided variation is where people copy others but try out their own solutions so that there is a lot of unique variation.

Recent debates have explored the value of Dual Inheritance Theory in relation to examples such as the persistence of hoplite warfare in Greece from the mid 7th

to mid 4th centuries BC (Runciman 1998; Hallpike 1999, Dunbar 2002). Bettinger and Eerkens (1999) apply the approach to prehistoric projectile points in California and Nevada. At about 1350 BP there is a decrease in size of projectile points that equates with the shift from use of the atlatl to the bow and arrow. In central Nevada, light narrow based forms were introduced for use with bows and arrows. But in eastern California light forms were sometimes narrow, sometimes wide based. There is more variation in projectile points in eastern California. Bettinger and Eerkens apply the Boyd and Richerson notion of guided variation (in which people copy others but try out their own solutions so that there is a lot of unique variation), and indirect bias (in which people copy social models and stick to them as when people copy successful hunters). They suggest that eastern Californian bow and arrow technology was maintained by guided variation so that there is more variation, whereas in central Nevada it may have been maintained by indirect bias. A possible reason for this difference is that in eastern California people obtained the bow and arrow from people they only interacted with minimally, so there was more experimentation (Bettinger and Eerkens (1999: 238).

Boyd and Richerson (1985) certainly contribute to our understanding of why certain forms of social learning are selected for in certain environments. But the accounts of culture in Dual Inheritance Theory often seem disconnected from developments in social and cultural anthropology. In most cultural anthropology, culture is no longer understood as a packet of beliefs handed down from one generation to the next. As soon as one says 'cultural evolution refers to the changing distributions of cultural attributes in populations, likewise affected by processes such as natural selection but also by others that have no analog in genetic evolution' (Shennan 2008: 76) the floodgates seem opened to all the possible factors that anthropologists have discussed over decades in exploring how people manipulate material culture socially. It is inadequate to gloss this complexity in terms of forms of biased transmission. There seems a real need for the more nuanced types of perspective seen in materiality or agency or memory studies (Dobres and Robb 2000, Meskell 2005a, Miller 2005b, Van Dyke and Alcock 2003). Dual Inheritance accounts of culture as transmitted information, held in the brain, seem a long way from, for example, Taussig's (1993) subtle accounts of the mimetic process. In most anthropological work material culture is nowadays seen as actively engaged in social processes. What and how culture (in the Boyd and Richerson sense) is transmitted depend on culture (in the anthropological sense) – that is on the active engagement of people in their entangled lives.

If we take a more anthropological view we see that humans and things are caught up in complex webs – and these webs of technology, social obligation, exchange relations, phenomenological understanding, ideological perspective, social jockeying are all part of the complex environment that mean that a certain trait is or is not used. One thing depends on another thing. It is these entanglement processes that produce so-called battle-ship curves, and it is within them

that transmission takes place or ceases. We need to focus more on the selective context that leads to the persistence of traits, and focus less on the humans and their transmissions one to the other. In biased transmission, a results bias occurs when a particular way of doing things seems more effective, but what is effective depends primarily on the rest of the entanglement. The increases and decreases of a results bias are primarily to be understood in terms of the shifting entanglement as a whole. In the case of the Californian and Nevada projectile points, research could explore how the different arrowhead shapes relate to function. The authors discuss the effects of resharpening, and the availability of materials may have had an impact within the projectile point entanglements. Variability versus conformity in projectile points through time may have very little to do with transmission itself.

One approach to the inheritance of cultural traits is to model the transmission process as random drift. The null hypothesis is set up that innovation occurs and individuals copy at random, without any form of bias. Variations from the random drift expectations can then be identified (Bentley *et al.* 2004, Eerkens and Lipo 2005). Recent work, however, has shown some of the difficulties here. Mesoudi and Lycett (2009) find that some combinations of non-random processes can produce frequency distributions of traits very similar to those produced by random copying. Steele *et al.* (2010) explore rim variation of bowls in two phases of occupation of the Turkish Upper City of Boğazköy-Hattuşa where it has been argued by the archaeologists that there was an increased use of solid versus liquid foods, an increase in larger vessels and an increased use of coarser wares perhaps to save labor. Steele *et al.* suggest that these other factors may be more important than the rim details in determining the waxing and waning of styles. An entanglement approach would explore these multiple factors.

A further problem that is also relevant to evolutionary archaeology concerns the methods of identifying cultural sequences and lineages. Any object can be defined in limitless ways, and so which characters and variables are to be chosen in constructing lineages by archaeologists? The construction of lineages in language has been relatively successful but material culture is more frequently manipulated by people as they memorialize some things and forget others. Anthropologists have long studied what Hobsbawm and Ranger (1992) called 'the invention of tradition', and prehistorians of all people know that typological similarities and differences can be manipulated by political interests in order to construct lineages and sequences of affiliation (Diaz-Andreu and Champion 1996). It is a very outdated view of anthropology and culture to imagine that culture is a package of stuff that is just handed down, objectively marking descent. In fact sequences and lineages are always to some degree invented – both in the past and in the present. If Dual Inheritance Theory accepts the play of these biases in the past, then it must also accept their role in the construction of affinity and descent in the present.

Evolution and Entanglement

The great attractions of evolutionary theory for the study of entanglements and their change through time include, as noted at the start of this chapter, the focus on the long term and the thing-centered perspective. But can the approach be modified to allow an understanding of the ways in which things and humans are selected within entanglements?

At first sight the prospect seems hopeful. As noted at the start of the chapter, one important strut of evolutionary theories is variation. I have argued throughout this book that things are always going wrong, running out, dying out, being unruly along the strings of entanglements. It may seem inadequate to try and develop a theory of long-term change that is based on 'things going wrong', but this is a core component of Darwinian explanations of evolutionary change where spontaneous gene mutations create variability. Things do not go wrong randomly for the most part. Things have their own temporalities so the timing of when they cause problems or back-ups or bottle-necks may seem random to humans. Things have their own relationships and interactions so that how things go wrong is structured to some degree. Humans also produce their own immediate variability as they engage with others and with things within the entanglements.

But we run into greater problems when approaching a second strut of evolutionary theory: inheritance and transmission. While humans do of course learn from those around them, they are also prone to tinker and transform (Gombrich 1979, Levi-Strauss 1965). They often seem tradition-bound (Hosfield 2009), and yet they just as easily invent traditions (Hobsbawm and Ranger 1992). Whether they do or do not copy and repeat what is around them depends. And so we are taken immediately into all the dependences and dependencies that have been discussed in this book regarding human-thing and thing-thing relationships. Humans work within a corpus of things around them that they refer to, but the factors affecting whether they copy or not include whether they can afford to copy and whether the copies are consistent both abstractly and in terms of bodily resonance. The tautness of the entanglements, the degree of entrapment, influence what is inherited and transmitted. People can rarely afford to copy prestigious people (context bias) or stick to the imitation of a successful role model (indirect bias) or copy more effective solutions (results bias). Whether they can try out their own solutions (guided variation) depends.

Similar concerns surround the third strut of evolutionary theory: differential fitness. In evolutionary theory this fitness usually means reproductive success within specific environments, measured in terms of survival of offspring down several generations, efficiency of resource acquisition, or success in replication as successful people are copied. While all these factors must be relevant, to greater or lesser extents in different contexts, they are themselves embedded in entanglements of humans and things that are complex and entrapping. Rather than focus

on fitness, I have suggested in Chapter 6 that the more inclusive term of fittingness be used. This incorporates affordances, abstractions and resonances that are woven together and influence whether a trait is likely to survive or not. A trait may be fitting and survive in such an entanglement regardless of whether it enhances reproduction, efficiently acquires resources or is used by successful people. Fittingness itself is an adequate framework within which traits are or are not selected, prosper, persevere and die out. Fittingness is a heterogeneous matrix: it does not require a reductive moment. It allows a non-reductive evolutionary theory.

It could be argued that there is another way to think the linking of evolutionary theory and entanglement. Human-thing entanglements can be seen simply as environments in which genes and cultural traits circulate. Thus variation, inheritance or transmission and fitness take their place within specific entanglements. So, following the outline of evolutionary theory described above on p.140, (1) variation in genes and traits is continually produced within entanglements; (2) This variation interacts with entanglements to form human-thing phenotypes; (3) These phenotypes (such as a domesticated cow) and genotypes (such as lactose tolerance in humans resulting from the consumption of cow milk) are differentially successful in surviving, reproducing and replicating; (4) New generations of humans and things inherit the genotypes or develop the phenotypes of previous generations; (5) The proliferation of more successful genotypes and phenotypes results in transgenerational increase in phenotypes that are more fitting within entanglements.

This scheme seems to work in a general sense, but with the same caveats as noted above. Evolutionary theory provides no anthropologically adequate account of processes that lead new generations of humans to inherit phenotypes from previous generations. We have also seen that the very definition of traits as phenotypes is fraught with difficulty so that a rigorous anthropologically based description of lineages of traits must depend on understanding how traits work in specific contexts – that is they must depend on the full gamut of dependences described in Chapters 2 to 5 and on the analysis of entrapment and fittingness as discussed in Chapters 5 and 6. Evolutionary approaches in archaeology focus on the 'battle-ship' curves of increases and decreases in the frequencies of traits, these lineages of inheritance. It is of interest that in South American archaeology the Spanish term for battle-ship curve is 'huso', meaning spindle and referring to the way a spindle is swollen into a lenticular shape by the wool wrapped around it. Thus an alternative to the idea of blocks of culture passed down through time is again the idea of strings of entanglement bundled together in specific ways in specific moments of time.

Dependences, abstractions and resonances select for certain traits certainly. This is the attraction of including some aspects of evolutionary theory in a theory of entanglement since the selection of traits can be considered without focusing only on human intentionality and agency. Abstractions, resonances and what can be afforded all have an impact on entanglements and thus on the

selection of traits. As already noted evolutionary theory plus entanglement allows a non-reductive approach to the evolution and persistence of humans and things. Within evolutionary theory an argument closer to the one being made here is provided by the concept of niche construction.

Niche Construction

Organisms, including humans, often modify their environments and in so doing they affect which genotypes survive and reproduce (e.g. Durham 1991). For example, many mammals build burrows that create an environment in which burrow defence, maintenance and regulation are selected for (Laland *et al.* 2000), and humans build cities which have an effect on gene transmission as a result of increasing epidemic disease, while the buildings themselves within the cities provide ideas about architecture without any teaching being involved (Shennan 2009: 7). 'Niche construction refers to the activities, choices, and metabolic processes of organisms, through which they define, choose, modify, and partly create their own niches' (Laland *et al.* 2000: 132–3). 'The reciprocal feedback between organisms' activities and their selective environment is known as niche construction' (Jablonka 2011: 784). The environments organisms construct influence the evolution of those organisms and of other organisms.

There is much here that parallels the focus on temporality and entanglement in this book. There is a real interest in material legacy. The earthworm transforms the soil in which future generations of earthworms are selected, or the burrow is a physical legacy influencing future evolutionary pathways. Each offspring inherits not only genes but also an ecology modified by ancestors (Kendal *et al.* 2011: 786). An ecological inheritance is thus added to genetic inheritance in evolution. This ecological inheritance can be expanded to include cultural transmission, by which Kendal *et al.* (2011: 787) refer to 'semantic information – anything that reduces uncertainty about selective environments, relative to the fitness interests of organisms'. Culture is again seen as conservative, traditional and static rather than as fluid and processual. Another recurring limitation is that much of what is inherited and passed down has nothing to do with the fitness interests of organisms, at least if fitness is defined in terms of reproductive success. So again we need to shift to fittingness in all its forms (resonance, affordance, abstraction) if we are going to understand why certain forms are selected for and become common.

Despite these caveats, studies of niche construction seem much closer to the arguments in this book that things themselves are involved in entanglements and temporalities that produce continuities in the lineages of humans, their genes and their cultural products. Riede (2011) conducts a case study from the southern Scandinavian Late Glacial in which the phylogenetic relations between projectile points are traced. The different types of lithic tool could then be explored to see if

they were associated with the use of dogs for hunting and intensive reindeer exploitation. The hypothesis was that when communities could not make use of dogs in herding, intensive reindeer exploitation was less viable. Although some of the statistical results were disappointing, the study suggests that the association of dogs with reindeer leads to greater reproductive and replicative success. This discussion of niche thus draws the understanding of the evolution and persistence of tools into a broader entangled context.

A further example of niche construction concentrates more on the evolutionary ecology approaches described in Chapter 4 and the Human Behavioral Ecology perspective on evolutionary change described earlier in this chapter. In their account of niche construction, Broughton *et al.* (2010) return to the example of the diet breadth model and the expanded array of lower-return resources that came to be exploited in many parts of the world in the early Holocene. Broughton *et al.* provide two archaeological examples of how resource depletion can act as a form of niche construction. In the case of Late Holocene hunter-gatherers of the lower Sacramento Valley of Central California, they show gradually increased use of smaller animals and fish and also low return plants. Since animals with larger bodies provide greater return for effort expended, this increase in diet breadth and use of low ranked resources indicates lower foraging efficiency. They also find evidence of increased violence and declines in human health in the skeletal evidence through the same time period. Thus it is argued that the increased diet breadth changed the selective context for human health.

In the case of the Mimbres-Mogollon culture in southwestern New Mexico, Broughton *et al.* extend the argument to a consideration of the reasons for agricultural intensification. They argue that intensification will occur if individuals experience a decline in foraging efficiency, perhaps as a result of the depression or over-use of wild resources. A shift to smaller prey is again identified and interpreted in terms of lower foraging efficiency. This lower efficiency resource system created a selective niche that favored more intensive agriculture, and indeed various measures, including changes in settlement location, do show increased agricultural use of the environment at this time. Broughton *et al.* (2010: 407) provide some interesting examples of the types of trade-offs involved in such a process. 'Engineering studies show that the "capacity" of a grinding implement, or its output per unit time, is a function of its grinding surface area: larger tools can be used to grind more material to a given consistency in a given amount of time than can smaller tools. The use of larger grinding tools entails a trade-off, however, because they also require more physical effort on the part of the person doing the grinding. Given this trade-off between tool efficiency and the degree of effort required, it is to be expected that larger grinding tools will be used when more time is spent using them'.

The increase in agriculture in the Mimbres-Mogollon is thus seen as a response to the reduction in returns provided by wild resources. Broughton *et al.* (2010: 410) recognize that many factors were involved such as settlement change, grinding tool technologies, the emergence of hereditary inequalities, migration but they

focus not on an interconnected system in which there are multiple causalities, but on the one factor of resource depletion as creating a niche in which selection occurs. Rather than isolating one variable as 'the niche' and focusing on resource depletion as the primary causative factor, it would be more productive to explore the interaction of many variables within an entanglement. Indeed, the depletion of resources and the shift to resources requiring more labor provide an excellent example of entanglement: the decline in a natural resource produces entrapment into increased labor. But to focus, as in many of these evolutionary and behavioral ecology approaches, on resources and reproductive success produces a lop-sided view of the complex entanglements of humans and things (see the discussion of Human Behavioral Ecology in Chapter 4).

The concept of niche construction brings evolutionary approaches closer to entanglement as defined here, and yet the notion of niche remains rather passive, a background to change, rather than engaging with the dialectical tensions between all the dependencies and dependences within the full realm of entanglements. There remains the potential, however, for exploring the ways in which an evolutionary approach can contribute to understanding the transformations of entanglements. In the next section an example is provided at Çatalhöyük.

Evolution at Çatalhöyük

Returning to Çatalhöyük, the Neolithic entanglement with clay, associated with a domestic mode of agricultural production, led to the mud-brick house (Hodder 1990, 2006b). The mud brick house was the social focus of material, social, symbolic and sensual life. Some houses started and then finished after no, or just a few, rebuilds, the vacant lot then being used for midden. Other houses were more successful, being rebuilt in the same way and in exactly the same location up to six times (Hodder 2006b). This variability of surviving and non-surviving houses seems ripe for a Darwinian analysis. Surely the long-lived houses were those with greater reproductive or replicative success?

The evidence at present intimates that the Çatalhöyük houses may not have been machines for the reproduction of genes. Using tooth morphology as a proxy measure for genetic distance, Marin Pilloud (2009, Pilloud and Larsen 2011) has demonstrated that individuals buried beneath the floors of houses were not more closely related to each other than individuals in the population as a whole. And those buried beneath the floors of the long-lived houses do not seem to have been better off in terms of health either. The health indicators so far studied by the team led by Simon Hillson and Clark Larsen (pers. comm.) do not show differences between the long-lived and shorter term houses. And there is no evidence so far of greater productive success. Storage and productive space, for example, remains much the same in both long-lived and short-term houses (Hodder and Pels 2010).

It is possible to argue instead that the houses that successfully persisted were those that were fitting in relation to other aspects of entanglement at the time. They were the ones that were most successful at performing this local version of what Maurice Bloch, Webb Keane and Peter Pels, working at the site, have classified as a version of a 'house society' (Bloch 2010, Keane 2010, Hodder and Pels 2010). Those in the long-lived houses were most successful at keeping the walls up, repairing them and furnishing them. They were the ones that were most effective at using ancestral cults and memory construction to keep the house going. They were the ones that were best at constructing 'history' through the passing down of animal and human skulls and body parts. They were the ones that best performed a particular material, social, symbolic and sensual repertoire – they did things that were fitting within a particular entanglement involving clay, bricks, skulls, bulls and houses but also involving ideas of history, ancestry, relations with the dead. We can find no evidence that the long-lasting houses controlled production or exchange or had better resources in some way. Rather, once they had successfully started to build a history and to amass evidence of that history (skulls, bucrania, body parts, images of feasts), these houses were able to elaborate on and perform that history more powerfully than others. So an entanglement in which history was important, and which was itself fitting within the long-term relations of delayed-return economies (Woodburn 1980), was a context or niche in which those humans and things good at building continuities and memories were more likely to be successful and be selected for.

Individuals at Çatalhöyük were sensuously tied to clay and to the clay house and hearth (Hodder 2011). We have seen also (Chapter 4) that they engaged in a variety of strategies to keep the house from leaning and falling apart. The more it fell apart, and the more humans caused change to the local environment, the more they had to intensify, change brick technologies, build thicker walls. Looking after the house involved recruiting the ancestors to hold up posts. A good feast may have not only solidified the social ties of the 'house' of people but may also have helped the material house to stand. In performing history humans depended on the house, but at the same time the house depended on humans. House, human and society were all materially entangled together. Any material, technological, social, symbolic, stylistic change only persisted in so far as it was fitting within these entanglements.

The introduction and spread of pottery at Çatalhöyük provides a further example. Fired clay objects and plaster occur from the earliest levels (around 7400 cal BC), but fired clay pottery starts in Level XII, at around 7000–6900 cal BC. At first the quantities of this thick, undecorated, organic (straw) tempered pottery are very small (Last 2005, Table 5.2), increasing gradually through time. There is little evidence from exterior smudging that these early, thick, small vessels were used in cooking over a fire. Rather, in the early levels up to Level VII cooking seems to have been achieved with the extensive use of balls of clay that were heated and placed with food in containers of basketry, wood or clay (Atalay 2005).

Figure 7.1 Mineral tempered cooking pot from Çatalhöyük (Source: Çatalhöyük Research Project and Jason Quinlan).

Around Level VII, these clay balls die out and at the same time pottery changes to being thin-walled and mineral tempered (Figure 7.1), and the pots have larger capacity. Frequent evidence of smudging on the outer surfaces of these pots suggests they were used in cooking, and experiments in behavioural archaeology have shown the greater efficiency of heat transfer in mineral-tempered pots in contrast to organic-tempered pots (Skibo *et al.* 1989). So what was it that selected for the use of clay pots in cooking instead of clay balls in Level VII at Çatalhöyük?

Careful comparison of cooking with pots and clay balls, using ethnographic and experimental data, demonstrated that the main advantage of cooking in clay pots over a fire was that the cook was more able to do other things at the same time (Atalay 2005). Use of clay balls involved continual monitoring of the cooking process, moving the balls back into the fire as they cooled down, shifting the balls around. But a cooking pot could more easily be left on the fire, acting as a 'delegate' of the cook (Latour 2005). The cook was more able to do other things and leave some of the cooking to the pot. Efficiencies of this type may well have become significant around Level VII in the Çatalhöyük sequence since it is in Levels VII and VI that the settlement seems largest and most densely crammed with houses.

There is also more evidence of symbolic elaboration and burial in houses in Levels VII and VI. With more going on in the houses and more pressure on available resources, behavior (or human-thing entanglement) that allowed greater efficiencies and multi-tasking in houses was selected for.

But the entanglements between humans and things at Level VII were yet more complex. The shift to sandier bricks described in Chapter 3 also occurred in Level VII. As noted above, this shift in brick composition involved new sources of clay and new technological processes as bricks were now made and dried prior to being brought to site. The shift to new sources of clay with mineral inclusions and off-site production of bricks could have had an impact on the simultaneous switch to the production of pottery with mineral inclusions (Doherty 2008). The same sandier clays used in the bricks were also used in making pottery in Level VII and after.

Another aspect of the entanglement of cooking pottery was its use for processing animal fat. Residue analysis has suggested that the mineral tempered cooking pots were used for processing the fats of small ruminants, probably domesticated sheep and goat (Copley *et al.* 2005)). There is much evidence from the faunal remains that domesticated sheep and goat were by far the most common domestic animal at the site, and that the bones were very carefully processed to remove all fats and grease (Russell and Martin 2005). Given the importance of sheep and goat in the diet, and the intensive labour involved in breaking up bones to gain fats, the efficiencies gained by switching from clay balls to pots in cooking would have been significant.

I have described the fittingness of mineral tempered cooking pottery in the entanglements of Level VII at Çatalhöyük. But why was that pottery undecorated (Figure 7.1)? Why was undecorated pottery fitting in the main sequence at the site? As we have seen, the cooking pots were used to process domesticated sheep and goat products. These animals hardly, if ever, appear in all the rich symbolism at the site. It seems fitting, therefore, that the pots in which their fats were processed were similarly not decorated. Rather, decoration and symbolism concentrated on wild animals, on hunting, baiting and feasting on them, as well as on burial (Hodder 2006b). Burial platforms in houses are often marked with red ochre or painted decoration. It is remarkable too that a clear rule existed at Çatalhöyük: whole pots could not be placed in graves with humans. Pots, rather, were entangled in a world of domestic production and processing, separated from the entanglements surrounding the production of histories, wild animals, death and burial.

Except, that is, for the pot shown in Figure 6.4. This was a one-off. Found in pieces in a midden in the northern part of the site, probably close to Level VI in time, this is a remarkable pot. Not only is it unique in levels in which all pottery remains undecorated, but also it encapsulates so effectively the main themes in the production of history at the site. The pot has a human face at either end, with eyes not marked. At Çatalhöyük, a human skull has been found with facial features modeled (Hodder 2006b) in plaster. The eyes are not shown and the same lack of eyes is found on the pot, and so it is possible that the human faces

Figure 7.2 Chalcolithic painted pottery from the West Mound at Çatalhöyük (Source: Çatalhöyük Research Project and Jason Quinlan).

on the pot are of the dead. On the two sides of the pot are shown the heads of bulls. It is mainly bull and human heads that are collected and kept or passed down at Çatalhöyük in order to build histories. Wonderfully creative as it is, this pot was never copied, never transmitted. It is in the wrong medium. At this time in the occupation of Çatalhöyük, all pottery was undecorated because it was entangled in cooking and sheep and goat fat. This decorated example did not get copied. It was not fitting in the entanglements at the time.

At the end of the Çatalhöyük sequence and on the ensuing West Mound, decorated pottery of the type shown in Figure 7.2 appears. This time the decoration is massively copied. This time decorated pottery, sometimes with human and animal imagery, is introduced, spreads and the new trait persists for at least 500 years. The proliferation occurred because a new set of entanglements gradually emerged in which pottery got caught up. The propensity towards pottery decoration at Çatalhöyük increases gradually from Level V upwards (towards Level I) at the same time that we begin to see shifts towards an erosion of the emphasis on the production of history in the house, so that there is less evidence of exact repetition of houses built on top of each other in one place, and less of the bull and other installations in houses (Düring 2006). It is possible that wild bulls became less available in the landscape after the intensive hunting in Levels VII and VI. In the uppermost levels (III and above) the excavations by Team Poznan have found a tomb rather than in-house burial (Marciniak and Czerniak 2008) and by the Chalcolithic West Mound (6000–5500 cal BC) there is no evidence of adult burial

beneath platform floors. In the latest levels at Çatalhöyük and on the later West Mound the houses change in character. The houses become larger, with more rooms, and with more storage and productive space. The hearth moves into the centre of the main room and pottery is used both for cooking and for serving and consumption. It is mainly this display pottery that is decorated. Pottery decoration in this context was fitting. It allowed the expression of productive potential around the central hearth in these new large houses focused on production (Hodder 2006b).

In this account, we see cooking pottery increasing, and then decorated pottery increasing. And we do see continuities of tradition in which transmission must have played a part. But really the persistence of that tradition can only be loosely linked to reproductive success of the carriers – it is difficult to see how one could even begin to explore that idea in the archaeological data (unless one resorts to proxies such as the varying economic success of households for which, as we have seen, there is little evidence). And it seems unlikely that we can explain all this by mode of transmission – even if we could demonstrate what that was. Rather the increase of cooking pottery and then the increase of decorated pottery are tightly linked to a complex interweaved web of other changing factors – the role of the house, the placing of the hearth, the production of bricks, the role of cooking, etc. The battle-ship curves (or spindles of wool) for cooking pottery and decorated pottery both show gradual increases. But the key to understanding these lineages is not reproductive success or mode of transmission. It is in getting to grips with the selective context for reproduction and transmission.

Fittingness here is different from fitness in natural selection in that the former is not based solely on reproductive success or survival but on how a trait works within entanglements consisting of the mutual dependences of humans and things. But as in Darwinian evolutionary theory, change in human-thing entanglement comes about through the co-evolution of traits. Entanglements change through the co-fittingness of traits and their mutual adjustment. This change can be gradual or sudden depending on numerous contingent factors and on the complex interactions of variables, as complexity theory has so effectively argued (Kohler and Gummerman 2000 and see Chapter 8).

Conclusion

So it may be the case that the pin on the shackle that holds up the mainsail on a boat could in some way lead to the reproductive success of the owner or user of the boat. It might at some point be possible to prove that people with boats with this type of threaded pin are more successful in leisure racing than other boats and as a result have children and great grandchildren that survive longer. It might also be possible at some point to show that this type of pin on a shackle persisted

longer than other shackle pins and had greater replicative success because owners of this type of boat had more status and were more likely to be copied. But in both cases the reason for the success of the shackle pin is not to be found in reproductive or replicative success but in the fittingness of the pin in relation to other things and humans in a specific entanglement. The fittingness of the pin may or may not enhance the reproductive success of the owners. It is likely to enhance replicative success for the pin. In both cases fittingness is established in relation to overall entanglements.

In describing the transformation of human-thing entanglements through time it has become clear that some sort of engagement with Darwin-inspired approaches is useful as they deal with the long term and de-center from humans to the things that get selected for. But two of the struts of these theories, selection and transmission, seem more acceptable if reworked within a theory of human-thing entanglement. These shifts in focus lead to a non-reductive theory of change that explores innovation and the selection of traits in relation to the tautness of heterogeneous entanglements rather than in relation solely to reproductive success, resource acquisition and the transmission of information from successful individuals. We shall see at the end of the next chapter that a focus on the entanglements within which traits are selected can lead to a macro-evolutionary approach rather different from the evolutionary approaches discussed in this chapter.

Chapter 8
Things happen …

Life is what happens to us while we are making other plans.

(Allen Saunders)

So if we take over from the last chapter the aim of integrating evolutionary accounts into less reductive, more anthropologically adequate discussions of the selection of things and their persistence through time, it may be useful to explore other approaches to cultural change that pay attention to heterogeneous complexity. Throughout this book, I have drawn attention to the ways in which the different temporalities of things and humans result in the unruliness of things. The unruliness and uncertainty create variation from which selection occurs. But traits are selected and persevere in highly complex environments. For some time archaeologists have been attracted by theories of complex systems. Renfrew stimulated a discussion of Catastrophe Theory in the 1970s and 1980s (Renfrew and Cooke 1979) and more recently the non-linear properties of complex self-organizing systems have been discussed by van der Leeuw and McGlade (1997; see also Redman 2005, Kohler and Gummerman 2000, Bentley and Maschner 2003, Bentley *et al.* 2005, Lane *et al.* 2009).

As we shall see, discussion of the complexity of entanglements in relation to debates about change in open systems leads to two main questions. The first asks why it is that entanglements tend to increase in scale and complexity. Is there a directionality to human-thing entanglements, and if so why? The second question concerns the expectation that as entanglements increase in complexity and extent they become more fixed and difficult to change – more entrapping. But in fact archaeology shows an exponential increase in the rate of change as entanglements increase in scale and complexity. Why is this?

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The Complexity of Entanglements

Open, Complex and Discontinuous Entanglements

In Figure 3.1 I identified some of the factors involved in lighting a simple fire in a hearth. The variables were bounded by the diagram into a closed system. But In Chapter 3 I showed how in any particular case the wood may be too wet to light, the wind may have changed direction, or one's hands may be too cold. In addition there are numerous social considerations, such as whether the person who normally provides the firewood or fire stones has left the settlement for a day or whether a child is sick and needs a bigger fire to keep warm. The diagram cannot encapsulate all the variables that might end up being relevant to a fire lighting. The system is open and other variables come into play all the time. In practice, one has to work it out, to cobble something together.

My entanglement diagrams (such as Figure 3.1), or something like them, might exist as cognitive structures in a fire-lighter's mind. Presumably such knowledge could be stored in a number of ways – as lists learned by rote or with mnemonics, as groups of material kept in a recess in the wall of a cave, as operational sequences. Presumably how the information is stored is varied. But in actually making a particular fire we are forced to improvise and manage using all sorts of practical knowledge about wetness, strength of the wind, coldness of our hands, who is in the settlement today and so on.

The diagram gives the impression of controlled variables and determined systems. But as I argued in Chapter 5, entanglements are not holistic and bounded. They are open, partial and indeterminate. My opening a fridge to get some milk on a Monday morning may be only loosely entangled, if at all, with the decision by someone on the other side of town to use a B minor chord in a composition for a school play. Some things are not very closely related to other things. And the variables that are involved in one part of the entanglement at any one time are uncertain and complexly linked. Things get out of control.

Unruly Things: Contingency

Harold Macmillan, Prime Minister in Britain in the late 1950s and 1960s is reputed to have said, in response to a question from a reporter asking him what was most likely to cause a government to change direction, 'events dear boy, events'. Things are always going awry or offering new potentials and opportunities. It seems difficult to predict them. They just seem to happen. Things and their interactions with humans have temporalities that result in their coming upon us unawares.

Change can be initiated by events anywhere within an entanglement. Materialists would argue that significant change always starts in relation to the material conditions

of life. When productive resources can no longer be provided within a particular technology a tension emerges between the forces and relations of production, leading to conflict and change (e.g. Friedman and Rowlands 1977). Within ecological schools, climate change or resource depletion cause perturbations leading to change; some authors argue that when least costly technological solutions are depleted, more expensive solutions are developed (Tainter 1988). The work of the Annales school provides many examples from medieval Europe of change being instigated in ideational realms (Le Goff 1992, Duby 1980), and the social and political sources of change have been widely discussed (e.g. Renfrew 1984). Ideational, social and political realms produce events out of the interactions between humans and things, whether religious wars over access to holy places, social conflict over ethnic leadership or political tensions over forms of government. The conjunction of temporalities from anywhere within entanglements can produce events that elicit response and change.

Regulation is needed to build competitive games and careers around the not-completely-predictable bouncing ball in tennis. Society needs degrees of predictability in order to function. We need stable categorization systems in order to be able to give and exchange, in order to eat and sleep and think. Agency is possible only on the basis of a certain amount of order and regulation. And yet the openness of systems means that unruliness is always present. As discussed in Chapter 4, unruliness derives both from the falling apart of things and from the ways in which things unleash a human potential for conflict and disorder. Much as governments try to fix things and keep them in place, events keep occurring.

A focus on contingency is seen in the study of self organizing complex systems (Prigogine 1996, Van der Leeuw and McGlade 1997, van der Leeuw 1998). In exploring the non-linear properties of societal systems, these approaches escape from the traditional anthropological and archaeological accounts of culture as a coherent integrated whole. They focus instead on instability, and on 'becoming' rather than 'being'. This is an emphasis I have made throughout this book, arguing that things are really flows of matter, energy and information, unstable and unruly. There is a focus on disequilibrium so that evolution may proceed 'precisely because of the non-adaptedness or non-optimal states within system structures' (van der Leeuw and McGlade 1997: 11). As I described in Chapter 7, entanglements contain many components that may be fitting in relation to one goal or function but may not contribute to success in another realm. The different parts of a sail-boat may be fitting on one dimension but an encumbrance on another. And as we saw in Chapter 6, abstractions and resonances may get out of step with many aspects of the wider entanglements within which they are situated.

Conjunction of Temporalities

We live our lives with daily cares. We live to the beat of our hearts, the surge of our impulses and the injunction of our thoughts. In our short lives we see many seasons of birth and decay, social upheavals, wars and famines. But there is a temporality

to things that far exceeds our human spans. The sandstone wall that bounds an Oxford college gradually flakes and erodes until at some uncertain moment it requires intervention. The walls at Çatalhöyük gradually lean over until they have to be propped up. In Chapter 5 I used the example of the millennium bug that caused large expenditure to fix and resulted from decisions made decades earlier. As a result of the blast at the Cernobyl nuclear power plant in 1986 about 2.4 million Ukrainians have received some level of contamination. The site will be radioactive for at least 300 years (The Times June 2010). 9000 years ago in the Middle East, Neolithic cattle were domesticated. The massive increase in beef consumption over the ensuing millennia has led to cattle having significant environmental impact. They account for 18% of global greenhouse gas emissions, largely as a result of deforestation that makes way for animal feed plantations and land for grazing. More people than die of AIDS in southern Africa today lose their lives from tuberculosis, a disease that may have spread from cattle to humans. We are dealing today with problems that were set in motion long ago. The invention of the wheel in Eurasia six millennia ago led to horse-drawn vehicles, motor vehicles with engines measured in horse power, and to further carbon emissions, global warming and wars for oil.

I have described in earlier chapters the various types of chains within entanglements. There are the chains of dependences within the equipmental totality (see Chapter 2). So domesticating a cow involves the provision of pens that are made of stakes that are cut from trees with axes that are polished on skins and so on. There are also operational sequences that make up behavioral chains of procurement, production, use, discard or that involve the series of gestures that go into making a stone tool (Chapter 3). But in addition there are historical chains, lineages or genealogies (Chapter 7). Thus, the domestication of cattle in Eurasia preceded and was a precondition for the invention of the wheel. Through time these two heterogeneous strands or genealogies have followed their partially independent paths, at times coming into close conjunction, as in the initial invention of the wheel (linked to agricultural intensification and draught animals), and at times diverging, as vehicles became motorized and independent of horse and cattle (although the links continued through the use of tractors on farms, etc.). The genealogies of domesticated cattle and motorized wheeled vehicles have converged again recently in their joint contribution to greenhouse emissions and global warming. So each string or strand made up of heterogeneous components has its partially separate trajectory, and these trajectories come together at certain moments to create conjunctures that are difficult to control or predict.

A good example of this process is provided by Timothy Mitchell (2002) in his account of the spread of malaria in Egypt in the 1940s. In 1942, Rommel's Afrika Corps crossed the border from Libya and was halted at al-Alamein with terrible casualties. Meanwhile, at the other end of the country, descending down the Nile from Sudan, was the mosquito *Anopheles gambiae* carrying in its stomach the deadly malaria parasite *Plasmodium falciparum*. Over the three

years of the ensuing epidemic in the south, between one and two hundred thousand people died. 'The war and the epidemic interacted with a third threat to the country, a severe wartime shortage of food' (Mitchell 2002: 20). One of the main reasons for this shortage was the delayed effects of Nile dam construction that had started in the mid 19th century. The dams allowed most of the country's land to be converted to year-round irrigation. The annual Nile flood had previously fertilized the soil by depositing silt and nutrients. Now massive amounts of chemical fertilizer such as ammonium nitrate were needed, and by the late 1930s in Egypt most of these fertilizers were supplied by a German business group. These supplies were cut off in the war. In the south of Egypt the lack of fertilizer contributed to populations being weakened by famine and malnutrition so that malaria epidemic casualty rates were very high.

The relationships between all these contributing factors were complex. The network of dams enabled the mosquito to jump barriers from one region to the next. The dams also encouraged the growth of an aggressive pondweed which could be made use of by *Anopheles gambiae*. One of the attempts to eradicate the disease was to spread Malariol, diesel oil mixed with a spreading agent, over standing water to prevent the mosquito larvae from hatching. But Malariol was often used instead to keep the irrigation pumps going. On a larger scale, it proved difficult for fertilizer factories in Europe and America to provide more fertilizer because they had been converted into the production of another ammonium nitrate product, high explosives.

There were other complex and conjunctural relationships within and between this set of entanglements. I shall list three here. First, there was a shortage of quinine for use as a treatment against the infection because at the same time that the gambiae malaria was reported in Nubia the Japanese occupied Java, cutting off the Dutch cinchona plantations whose trees supplied the drug to Europe. Second, the construction of the dams in the inter-war years, including the Aswan dam, had proved a messy and haphazard process, and the interactions of things caused many problems and huge unexpected costs. The Portland cement used for the Aswan dam led to leakage and erosion, and there were subsequent problems of silt accumulation, seepage and evaporation. Ancient things got embroiled too as the dam inundated the Temple of Philae and other sites, leading to public outcry similar to the response to the construction of the Aswan High Dam and hydroelectric scheme in the 1950s. Third, the search in the textile industry in Europe for a mothproofing agent led to the discovery of the toxicity of dichloro-diphenyl-trichloroethane. In 1943 DDT was introduced as a way of eradicating the gambiae in southern Egypt. It was not known how DDT worked but through time it was realized that it killed beneficial as well as harmful insects, was poisonous to fish, and harmful to all forms of plant and animal life. It was not until 2007 that the United Nations Environment Program supported the end of the use of DDT altogether (Mitchell 2002: 49).

So the chain of events in Egypt connected war, disease and agriculture. There were connections between rivers, dams, fertilizers, food webs and capitalists. The linkages were thoroughly heterogeneous involving hydraulic, chemical, military, political, etiological and mechanical processes. The entanglements and conjunctions brought together different genealogies and temporalities in complex and indeterminate ways. The intersections between the strands are unruly, countered within regulatory discourses. Mitchell argues that in the Egyptian case there was an expansion of the 'rule of experts'. Indeed the problems caused by the Aswan dam gave rise to the new field of cost-benefit analysis (Mitchell 2002: 37) to which the theories of Human Behavioral Ecology are related, themselves thus discourses for the regulation of things. The rule of experts feeds off the continued uncertainties of the build-up of temporalities and their interactions.

Catalysis: Small Things and the Emergence of Big Effects

If we put three aspects of complex systems together – openness, unruly contingency and the conjunction of temporalities - then one conclusion is that small things and small events can have big effects within entanglements. There are many versions of this idea. For example, there is the butterfly effect in Chaos Theory where small differences in the initial set-up of a complex dynamic system can produce large variations over the long term (Bentley and Maschner 2003). Thus it becomes difficult to predict the weather over the long term as the starting conditions are difficult to determine precisely and because the system is complex and open. A related idea is the domino effect. This is a chain reaction that is self-sustaining and is set off by a small change. In archaeology, Deetz (1977) argued that 'small things forgotten' had hidden importance that reverberated through many spheres of life. In the Egyptian example provided by Mitchell, there were long-term processes such as the increased dependence on fertilizers as a result of dam construction and the increased erosion and leakage of the Aswan dam. But specific small-scale events such as the spread of the malaria-carrying mosquito into southern Egypt acted as catalysts that interacted with other conjunctural events and with the long-term processes to create large-scale change.

Sudden and large-scale change can also be produced by the slow and smooth interaction of variables. Relationships between multiple variables in complex systems may bifurcate, twist and turn (Renfrew and Cooke 1979) so that there is sudden, large-scale change, even though individual variables are only changing gradually. Systems may become unstable at such moments and spontaneously reorganize, creating a new order in the system (van der Leeuw 1998). This notion of emergent phenomena has widespread appeal. Van der Leeuw and McGlade (1997: 9) argue that these spontaneous restructurings of the social order lead to new institutions and practices emerging without a designing or directing mind. Van Huyssteen (2010) and Shults (2010) suggest that the human capacity for

religion may be an emergent property of other human abilities such as imagination and emotion within complex human systems.

In philosophy and the natural sciences, 'emergence is the view that new and unpredictable phenomena are naturally produced by interactions in nature; that these new structures, organisms, and ideas are not reducible to the sub-systems on which they depend; and that the newly evolved realities in turn exercise a causal influence on the parts out of which they arose' (Clayton 2004: vi). In the social sciences and humanities, there is increasing adaptation of this idea to explain change. Small-scale processes can in aggregate result in larger-scale patterns or processes that may be unanticipated and thus emergent (Adams 2001, Bentley 2003, Kohler and Gummerman 2000, Wilkinson *et al.* 2007). As an example, Jason Ur (2009) discusses the emergence of an urban settlement pattern and two thousand kilometers of roadways in Early Bronze Age northern Mesopotamia. Rather than seeing the radiating networks of roads around the settlements as coercively imposed by a centralized elite, he sees them as the unintended result of the interaction of small-scale processes. Each household within a nested hierarchy of households was motivated to increase production in order to support exchanges of food and drink. Household and personal relationships were forever being renegotiated through commensalism. Increased production involved increased movement of labor and livestock and carts and equipment and manure to the surrounding fields and pastures. Within the cultivated zone in particular, farmers, shepherds and their flocks adhered to the roadways to avoid trampling crops. Although there was some top-down extraction of surplus by elite households, the Early Bronze Age roadways were not constructed by a coercive central authority but emerged from the actions of individuals as they maintained their fields and took their animals to pasture (Ur 2009).

Agent-based models often include some form of emergence within complex systems. For example, in their Village Ecodynamics Project, set in southwestern Colorado, Kohler *et al.* (2000, 2007, 2012) seek to make various systems-level properties such as the local population trajectories, or the placement and sizes of residential sites, emerge from the interaction of households with each other and with the dynamic environments they inhabit. The study makes use of the high-resolution chronologies and climate proxies made possible by tree-rings. Kohler *et al.* (2011) use an abstract evolutionary public goods game to model the rise of leadership in the same area between AD 600 and 1300. In their model, households would prefer to live in a hierarchical rather than egalitarian society if leaders can reduce the likelihood of failures in cooperation due to free-riding or lack of cooperation. Such a shift is seen as optimal when cooperation as a group is needed but group size exceeds that in which leaderless cooperation is viable. Such a model successfully produces the emergence of hierarchy, but it does so at the expense of a full account of all the specific historical entanglements involved. As we saw with evolutionary and behavioral ecology accounts in Chapter 4 and 7, costs and benefits are evaluated only in universal terms. Hierarchical societies are

assumed to be more efficient in organizing cooperation, but the example of the dense population at Çatalhöyük that thrived successfully for at least a thousand years without significant hierarchy suggests that local and specific factors need to be taken into account. Models that assume a universal rationality need to be embedded within the possibility of different rationalities.

The focus in this book has been on the 'thingness' of things – that is their role in tying society, humans together into heterogeneous entanglements. This tying function leads to entrapment in a web that has affordances as well as abstractions and resonances (local forms of cost-benefit 'rationalities'). Things create assemblies around them, they draw people together. But things can also act as catalysts for change. A fence around a field can suddenly become a crisis point as neighbours argue over maintenance and access. 'A substance or thing chosen to stabilize an assemblage may successfully co-constitute it for a while. However, it has the potential to act against coherence because its emergent properties may no longer accord with the rest of the assemblage, or become untethered or melt away because it is *catalyzed* by other agencies from within and outside the assemblage' (Edensor 2011: 239).

Catalysis occurs in chemistry when a substance accelerates a reaction without changing itself. The word comes from kataluein, the Greek word to annul or untie. So things also have an untying function within entanglements. Human-thing assemblies may occur in a fairly stable state for some time, until something happens, a flash point occurs, and the strings of entanglement for a moment become untied and resorted. There was for a long time a fence around the Greenham Common military air base in England. It had functioned as an air base since 1942. But the deployment of nuclear Cruise Missiles at the base in 1980 led to the formation of 'women's peace camps'. These focused on the fence, on cutting it, forming a human chain around it, and on the gates through it. Suddenly a fence had become a catalyst for social movements, nuclear disarmament and political change. Another example of a material catalyst for change was the Native American occupation of Alcatraz in San Francisco Bay in 1969. After many years of Native American activism, the occupation of the prison and the claiming of it galvanized the Native American movement. In more recent years the flying of planes into the Twin Towers and Pentagon on 9/11 2001 acted as a catalyst for widespread change in security, surveillance and politics in the United States and globally. When street vendor Mohamed Bouazizi burned himself in Tunisia at the end of 2010, his act sparked a sudden and unexpected spread of revolutionary movements throughout North Africa and the Middle East.

In November 1989 a wall came down in Berlin. The dismantling of the wall that had long separated east and west Europe resulted from numerous complex factors. Some were long-term such as the gradual decline of the Soviet Union; others were medium-term such as pressure from the United States and Ronald Reagan; others were short-term such as the partial opening of the borders between Hungary and Austria in the weeks before the collapse, or the lack of communication between

political authorities in East Germany and the guards at the border crossings as crowds built up at the gates in Berlin on November 9 1989. 1989 was a year of revolutions partly triggered by the collapse of the Soviet Union. Earlier in 1989 the Tiananmen Square protests in Beijing were brutally put down. In Poland elections led to a non-communist government taking office in September 1989. In October 1989 a non-communist party was established in a new Republic of Hungary. The Velvet Revolution in Czechoslovakia led to the setting up of a non-communist government on December 10 1989. The collapse of the Berlin Wall and the reunification of Germany in 1990 were part of the breaking up of Soviet domination but they also acted as catalysts for further change. The destruction of the wall prised open the entanglement of the Cold War; suddenly change was possible. The dates of the toppling of communism tell their own story of the speed of change: 1990 – Lithuania, Slovakia, Romania, Bulgaria; 1991 – Latvia, Estonia, Belarus, Ukraine, Moldavia, Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Montenegro, Macedonia. It is often argued that the effects were much more widespread: in South Africa negotiations started in 1990 to dismantle Apartheid; in 1991 in Angola Marxism-Leninism was abandoned, as it was also in South Yemen, Mozambique and Congo (Antohi and Tismaneanu 2000).

Catalysis or untying occurs as the entanglement accommodates and realigns in reaction to events (another example is provided by the 1848 revolutions in Europe although most were quickly overturned). It is at these moments that there is an untying, an opening, a loosening of the entanglement. In that opening there is possibility for change, but also uncertainty in the untied moment, and sometimes a backlash. What results is always very contingent – it always depends. But it can be very radical as the web is for a moment loosened and it seems that 'anything can happen'. This untying also occurs mundanely as everyday events happen, one's fingers are too cold to light the fire, or the designated fire-lighter is out of the settlement. There is an endless tension between the tied-up web and the untying moments. Catalysis is going on all the time as things fall apart and events happen. In Chapter 4 I argued that things unleash potential in humans, whether it be the tool that releases the potential of the hand, a Beethoven chord sequence that awakens the possibility of individualism and romanticism, or a fence that crystallizes conflict. The outcome of the untying or unleashing can be very small-scale change or very large-scale disruption. It all depends. But often something emerges, contingently and unpredictably from the complex interactions of variables in the moment, that is new and enduring (at least for a time).

There is often a spatial component to the untying of entanglements. They are often most easily untied in places away from the center of an entanglement. It is in marginal peripheral areas where the entanglement is less dense, less regulated, less scrutinized that it can more easily be undone so that change occurs. It was on the western fringes of the Soviet block that the 1989 revolutions started. Throughout the history of Dynastic Egypt, the focal centers shifted from North to South and back again – in a catalytic transfer. While the classic entanglement of the Levantine

PPNB came to an end in the period around 6500 BC with many of the larger sites being abandoned, at the same time in central Anatolia there was a major expansion in the number of large sites including Neolithic and then Chalcolithic Çatalhöyük (Baird 2005). In recent centuries, Eurocentric and American-centric global systems are being replaced by the economic and cultural centrality of previously less-developed regions (India, Brazil, China).

Is there a Directionality to Entanglements?

If entanglements are open, complex and uncertain, continually generating emergent phenomena, it might be presumed that change is largely random or non-directional. Indeed, according to most contemporary versions of the evolutionary process it is non-directional. The idea of directional change was common in the 19th century when it was linked to ideas of progress. Versions of evolutionary theory such as that of Leslie White (1959) argued that societies moved in the direction of harnessing more energy from the environment in order to counter entropy. Social evolutionists often argued that societies became better adapted and more complex through time. In the 20th century many scholars became wary of such notions since any suggestion of directionality seemed in the interests of dominant groups who could argue for a natural progression towards 'people like us' and away from the less developed 'people like them'. This may be one of the reasons that Darwinian theories of change are increasingly popular since variation, transmission and selection do not by themselves lead in any particular direction (alternative macro-evolutionary perspectives are discussed at the end of this chapter).

Of course, saying that evolution is directional needs to be distinguished from the claim that it is influenced by history. Darwin was certainly of the view that evolution can only work on what is already there – the existing variability. Genealogy, heritability and transmission are at the heart of the evolutionary archaeology and dual inheritance approaches described in Chapter 7. But to note the historical nature of the evolutionary process is quite different from arguing that the process is directional. Social theorists have long pointed to the dangers of teleology in explaining long-term change. If we were just to say that hunter-gatherers became farmers and moved into cities because they had the aim or intention (the telos) of being farmers and city dwellers then explanation of the past would be very easy! It would also not get us very far as we would not have explained how the change occurred or how the idea arose. It is difficult to explain an effect by arguing that it comes before the cause!

Evolutionary change is historical but it is not teleological. It is not intent on going anywhere. And yet cultural evolution certainly seems to have direction. 20 000 years ago we were all hunter-gatherers. Today very few of us are, and those

of us that do live as hunters and gatherers have often developed in relation to pastoralists and farmers (Wilmsen 1989). The eradication of most hunting and gathering societies results from colonial expansion, global exploitation, destruction of habitats and so on. But why has it not gone the other way? Why have humans not returned to being hunter-gatherers? At times we have. For example, after the adoption of farming in northern Europe there was a return to hunting and gathering by Pitted Ware cultures (Whittle 1996) or a return by the hunter-gatherers themselves. The Okiek hunter-gatherers in modern Kenya move in and out of herding cattle and being pastoralists depending on the availability of cattle (Hodder 1982). Such 'returns' are usually short lived and they are seldom a return to less entangled lives. In an important rejoinder to Diamond's (2005) claim that societies sometimes 'collapse', contributors to the book 'Questioning Collapse' (McAnany and Yoffee 2010) argue that supposed collapses of societies usually see continuities and even revitalizations. There are of course many cases in which societies copy earlier times or return to earlier themes, as in neo-Classical or neo-Gothic or retro styles of architecture, music or dress. But these renewals are usually situated within entanglements that are quite different from the earlier versions.

It is very difficult to argue that there is not some directionality to human-thing entanglements. It is very difficult to claim that overall, along with huge inequalities in wealth and access to health, the world is not more entangled in terms of the scale and intensity of human mobilization of resources, communication and inter-dependence. Archaeologists in their introductory lectures expound the long-term shifts in technology, scale of society, elaboration of symbols, speed of communication and so on. Is it possible to find some non-teleological way of making sense of this apparent directionality?

A non-teleological directionality is produced very simply by the difficulty of going back down evolutionary pathways. It can be argued that complex systems have irreversible directions of change (van der Leeuw 1998, Prigogine 1996). In the study of self-organizing complex systems, history is reconceptualized 'as a series of contingent structurings which are the outcome of an interplay between deterministic and stochastic processes' (van der Leeuw 1998: 47). Directionality is not produced by a future orientation towards a better, more complex, more connected society but by the inability to go back. Why is going back so difficult?

We can return to some of the examples used earlier in this book in order to try and explore this question. As noted above, although cattle were domesticated over 9000 years ago we have become increasingly dependent on beef consumption. Indeed the domestication of cattle by humans has been an enormous evolutionary advantage for cattle as numbers have increased to about 1.5 billion head globally. These cattle are an enormous environmental cost; they take up nearly 27% of the land mass of the planet, consume enough grain and corn to feed hundreds of millions of people and account for 18% of global greenhouse emissions (Pollan 2006). As many environmentalists argue, we need to decrease our dependence on cattle but it would be impossible to go back 9000 years and do without domestic

cattle (and this of course is not being suggested). The global human population has grown too large to survive without this significant source of meat protein. Or take the example of the car, itself ultimately the result of the domestication of cattle which made the invention of carts and wheels possible. Emissions from cars contribute to global warming but we have all become very dependent on cars; it is inconceivable that we solve the problems of global warming by giving them up. That people commute to work is a cornerstone of modern economies and urban zoning; the layout of cities and the locations of industries are tied to the car, at least in countries like the United States and in states like California. It would be impossible to go back to using horse and cart rather than car. Life has become unthinkable without telephones, cars, electric lighting, and computing. These devices have become woven into our everyday existence and into our economies and social systems (Boivin 2008). Going back is not an option.

Directionality, at the most general of levels, is produced by a bias or imbalance in the ways humans go to and from things. I discussed the dual aspect of human relationships with things in Chapter 2. Humans go to and from things. If they went equally to and from things then it might be expected that there would indeed be no directionality in entanglements. But in fact humans can never escape things. I argued in Chapter 2 that human thought, feeling, existence depend on things. Human being is awakened in thingness, and so an immaterial human is a contradiction in terms.

More specifically I argued in Chapter 5 that entrapment in entanglements was like digging oneself into a hole. What one did earlier affects what one can do now. But this history is not just linear. And it is not just a story of events and humans. It is also a story of things and the traces they leave. Because of the duration of material things and their entanglement with each other and humans, even very distant decisions by humans still affect us today. There is a build-up of the past that surrounds us.

The sides of the hole we dig for ourselves are unstable and are always about to fall in. So humans are always involved in a process of investing more to protect what they have already invested in. They need to shore up the hole with planks and beams, struts and metal sheets. Entanglements always expand because as humans fix things that go wrong or run out along all the chains and strands, they make further investments, use new tools, seek new solutions, create new institutions, develop new social relationships and so on. The fixing occurs within the existing entanglement, but extending it in some way.

So when in a child's rhyme we say 'there is a hole in my bucket' the immediate response is 'then fix it' rather than 'let's stop using buckets and go back to pots'. The tendency is always to find solutions that work within what we have. This is not because people are inherently conservative but because it is in their interests (because of all the heterogeneous dependences) to minimize disruption to all the entanglements – a disruption usually spoken of as 'cost'. We saw in Chapter 4 that the costs and benefits are best seen as broader than optimizing effort and maximizing resource acquisition. The entanglements that are disrupted by catalysis are heterogeneous.

So we tend to fix things within the existing entanglements. These are always complex and dense so that in assessing costs and benefits and trade-offs it makes sense to minimize disruption to other parts of the entanglement. Most fixing involves making do, bricolage, tinkering. But as noted earlier, sometimes there are catalytic events and moments when large parts of the entanglement unravel so that major adjustments can be made. Even in these cases it may make sense to minimize change to parts of the overall entanglements.

The notion of digging oneself into a hole is comparable to the sunk-cost effect described in economics, and also called the Concorde fallacy (Arkes and Ayton 1999). The UK and France continued building the supersonic Concorde even though it had poor financial prospects, on the ground that they had already invested or sunk a lot of money into the plane. Economic decisions are often based on past investments rather than expected future returns (Janssen and Scheffer 2004). There is thus an unwillingness to abandon a path of action if a great deal has been invested in it, even if future prospects are not good. Human decision making is typically influenced by the level of prior investments (in a wide sense, including capital, experience, and spiritual values). In Chapter 5 I introduced literature on path dependence in which humans invest in a particular choice of action and the costs of switching to an alternative path increase over time (David 1985, Mahoney 2000, Pierson 2000). Often, however, it is not just the costs of changing a particular path that are prohibitive, but the costs of changing all the inter-linked paths. Whatever the investment, it may be difficult to abandon a particular course of action simply because the surrounding entanglements have pulled that action into a particular hole.

An alternative metaphor to the digging of an archaeological hole is turning the course of a ship. There is too much momentum and too much weight to make a sudden change of course. At the smaller scale I described in Chapter 5 the close relationship in momentum between human and thing when riding a bicycle. With the ship and the bicycle we see how the dependence between humans and things is a movement, a flow of energy, information, matter. Human and thing are each dependent on the movement of the other. And this momentum is dispersed through increasingly large entanglements; the example of the bicycle becomes less relevant and the ship more so as we move into larger entanglements. More and more things have to be changed round if change is to occur. 'Masterpieces are not single and solitary births; they are the outcome of many years of thinking in common, of thinking by the body of the people, so that the experience of the mass is behind the single voice' (Virginia Woolf 1928: 106). Woolf is talking here about the difficulties of turning around centuries of male dominance and prejudice. I have written of the 'movement of the mass' as underlying change in prehistory, and in particular in the lead up to the adoption of farming (Hodder 2006b and see Chapter 9).

Some will say that the directionality in the tide of humans is just the result of tradition. They argue that the non-discursive mind tends to get stuck in routines

and it is these that restrict change and going back. I doubt this. First because as argued in Chapter 6, non-discursive consciousness is highly complex and creative – as up for change as the rest of our being! And second, as noted in Chapters 6 and 7, while humans crave tradition they equally engage in the invention of tradition and the social manipulation of history. Traditions and routines have to be explained within entanglements rather than assumed to be universal characteristics of human becoming.

We can return then to the discussion of cultural transmission and the battle-ship curves that archaeologists identify in the increases and decreases of styles. In much evolutionary archaeology there is a presumed assumption that humans copy in a conservative way. Riede (2011) argues that patterns of style change in archaeology show that social and cultural transmission tends to be conservative. But in fact humans are always monitoring and considering the costs and benefits (across a range of cultural and economic domains) of continuing down one path or another. Part of that evaluation concerns the difficulty of going back. Once a strategy has been started it often makes sense to try it out and follow it through (hence the first part of the battle-ship curve), and there will often be those that continue building on their investments in a particular track even as other options become available (hence the decreasing 'tail' of the battle-ship curve). As noted in Chapter 7, an alternative metaphor to the battle-ship curve is the spindle wrapped in wool. The increases and decreases are produced by the overall web of entanglements and by the directionality that results from the costs and difficulties of going back.

There is thus an irony to entanglement. It is the transformative side of entanglement that wins out overall and in the long term. But the entrapment side of entanglement nevertheless has the effect of directing change both locally in terms of particular strategies within entanglements and more generally or globally, usually towards greater entanglement.

Some Neolithic Examples

Things started well as the Natufian culture emerged in the southern Levant around 14 600 years ago. Population increased and there was some degree of sedentism. The site of 'Ain Mallaha contained animals and birds from all seasons (Valla 1991) and there were commensals (such as the house mouse) indicating sedentism. Settlements occurred in the hill zones of Israel, Jordan, Lebanon and Syria, and related sites have been found to the north in Mureybet and Abu Hureyra. Settlements in the early Natufian in the southern Levant included base camps around 1200 m2 in size and containing clusters of semi-subterranean huts. The later Natufian, however, appears to have suffered a set-back during the climatic deterioration of the Younger Dryas (12 900–11 600 years ago). In the Levant many but not all hamlets dispersed and became more mobile (Bar-Yosef 2001). But there was no returning back to earlier Geometric Kebaran times.

Even though settlement had become more dispersed, small-scale and short-term in the later Natufian, people used abandoned early Natufian base camps as cemetery sites. A sense of place and history had developed in the base camps of the early Natufian; it is likely that social and economic systems had increasingly become entangled in delayed returns for labor input (Hodder 2007a). Even during more mobile and dispersed times, later Natufians continued to rely on a sense of history and place (seen in the reuse of settlements as cemeteries and in the circulation of human skulls) and they continued their intensive use of cereals and pulses (Zeder 2009). When better climatic conditions emerged after the Younger Dryas the stage was set for a return to sedentism and increases in site size, population and intensification of resource use in the PPNA.

Rather than talking in broad-brush terms, we can consider the specific case of a catalyst to change that occurred during the occupation of Çatalhöyük. Around Levels VI-IV (that is about 6400 BC) there was a decline in the frequency of wild cattle in the faunal assemblages. We cannot be sure that this decline was caused by decreased availability of wild cattle in the landscape, but this seems a likely explanation given the very intensive use of wild cattle in the preceding periods at the site and given the apparent introduction of domestic cattle during Levels VI–IV. Although there is some evidence of continued use of wild cattle in special deposits in the upper levels of the mound, any decreased availability of wild cattle would have been a major social and economic problem. For example, we know that wild cattle were central in the provision of feasts. They were central in the feats surrounding teasing and baiting wild animals. They were central to the construction of ancestry and history within houses. Wild cattle looked after the dead and revitalized the house. So their lack of availability caused a real untying of the entanglements that centered on the history houses and history making. A solution was the adoption (from farther east probably) of domesticated cattle. This of course was a new investment involving greater inputs of labor to tend animals, organize grazing, control breeding, build pens and so on. These new investments in domestic production led to major changes in the upper levels (IV–I) at Çatalhöyük. Houses became larger and became foci of domestic production.

Would it have been possible to respond to the decline in wild cattle by going back? Would it have been possible to go from Level IV at Çatalhöyük back to Levels VII/VIII – that is back 400–500 years to when the role of wild cattle in feasting and in symbolism in the house was just increasing? This would have been difficult. It would have meant building smaller houses again with less going on in them, less burial, less symbolism – less of all the ceremonies and social events that were supported by the teasing, baiting, killing, feasting and circulating of wild cattle and wild cattle parts. And after Level VII people had come to depend on pots while cooking in houses. The pots allowed them to get more done in the houses as more and more activities were brought into the house and as houses increased in size. But back in Levels VII/VIII food was

cooked without pots, but with clay balls. So all the social and economic relations surrounding the manufacture and trade of pottery would have to be undone. There would have to be a return to simpler obsidian technologies and a resuscitation of exchange routes and sources that had now been changed. In all these ways to go back would have involved giving up on investments, on ownership, on rich social networks and established histories. If the increase in house sizes indicates increased populations in houses, it would have been difficult to maintain these population levels within houses with simpler obsidian technologies and no cooking pots. It would have been difficult to hold the household group together without the feasting on wild cattle and the histories associated with them. Given increased population per house by Levels VI-IV it would have been hard work to go back to smaller houses with simpler technologies such as clay balls rather than pots for cooking.

Macro-evolutionary Approaches

A focus on directional change within evolutionary theory has been explored over recent decades by biologists and archaeologists. We saw in Chapter 7 that much evolutionary theory in archaeology concentrates on the micro-processes of variation, transmission and selection of genes and traits. Of course selection can only act on variation that is produced from within an existing pool of traits or genes, so in this sense Darwinian approaches are always historical. But most evolutionary theory in archaeology does not see the variation, transmission and selection of traits as leading anywhere or going in any particular direction.

Some recent macro-evolutionary processes take a different tack. Inspired by the work of evolutionary biologists Gould and Eldridge, archaeologists such as Spencer and Redmond (2001), Rosenberg (1994), Chatters and Prentiss (2005) 'reject neo-Darwinian perspectives that portray evolution as confined to changes in allele frequencies within individual organisms shaped by gene flow, genetic drift, and, especially, natural selection operating on phenotypic expressions of random genetic variation' (Zeder 2009:3). Instead they see organisms or groups of organisms as having bundles of traits that have a structure or architecture. Instead of focusing on the adaptive value of individual traits, the macro-evolutionists argue that the architecture and its history constrain the evolutionary process. Evolution operates at multiple levels at the same time – genes, organisms, populations and taxa. Some macro-evolutionists see the organizing architecture as made up of resource management strategies such as hunting and gathering or farming. Others place more emphasis on a socio-political architecture such as the organization provided by a band, tribe, chiefdom or state. Others such as Rosenberg see the architecture as ideational (Zeder 2009).

As a result of their focus on organizing architectures (Gould and Lewontin 1979), macro-evolutionists reject the neo-Darwinian view that evolution is

relatively undirected. Directionality is produced by the hierarchical nature of cultural processes; it is also produced by historical contingency or path dependency when cultural attributes are carried over from ancestral forms. Boyd and Richerson's guided variation and biased transmission produce a Lamarkian aspect to cultural evolution. Direction is also produced by 'exaptation' – this is when a feature takes on a new adaptive function different from its original function, leading to greater organizational complexity through time.

There are parallels between entanglement theory and macro-evolutionary theory, particularly with regard to the recognition of the directionality of change. Similar to the notion of exaptation is my argument that fixing tends to minimize disruption to other parts of the entanglement. Humans tend to work within what they have got within entanglements, and so there is a gradual cline towards organizational complexity. There are other similarities. Zeder (2009) argues that micro-evolutionists tend to see change as gradual but in macro-evolutionary theory, as in complexity theory, major change is seen as being possible very suddenly, at times producing punctuated equilibria (stasis and then rapid change). This notion is parallel to the emphasis here on catalysis.

But the main difficulty with the macro-evolutionary perspective in relation to human-thing entanglement is the rather mysterious role played by structure, architecture or bauplan (Zeder 2009). What exactly is this determining force? Where does it come from? Why do farming and hunter-gathering constitute different structures (after all many societies incorporate both forms of resource acquisition)? And why cannot socio-political structures include aspects of both tribes and chiefdoms, as indeed they often do? On what grounds do we identify structure – what is this mysterious thing? And why should it be either subsistence based, socio-political or ideational rather than a heterogeneous mix of all three? I suspect that in answering these questions fully, macro-evolutionists would end up with something looking like entanglement – a heterogeneous mix of humans and things with all their dependences, resonances and abstractions. The 'structure' or 'bauplan' is in fact just the tautness of the web produced by thing-thing dependences, human debts and obligations to each other, and so on. The hierarchical nature of the evolutionary process is produced by the different scales and temporalities of entanglements.

Why Do Entanglements Increase the Rate of Change?

In Chapter 4 I used a quote from Michel Serres who argued that material objects stabilize the relationships between humans. The quote continues in the following way. 'In fact, the object, specific to the Hominidae, stabilizes our relationships, it slows down the time of our revolutions. For an unstable band of baboons, social changes are flaring up every minute… The object, for us, makes our history slow.' (Serres 1995: 87 and see Olsen 2010). I argued in Chapter 4 that the mistake here

was to be fooled by the short-term experience of our lives or of ethnographic enquiry into assuming that material things made by humans were inert. In fact they are always falling apart or drawing humans into their own cycles of existence.

I argue that as entanglements increase in size and complexity their rate of change increases. What is the evidence for this? I wish to take again the example of the adoption of farming in Turkey and the Middle East. As Renfrew has noted, at the start of the Holocene 'human culture became more substantive, more material' (2001: 128). Of course, humans had always lived in a material world, but by the start of the Neolithic much more of this than ever before had been interfered with by humans and had indeed become dependent on humans. Social life had become encumbered with domesticated plants and animals, but also with all the necessary tools and equipment. Ground stone, polished stone, worked bone, fired clay, multi-component microlithic arrowheads were all added in the Pre-Pottery Neolithic to substantial mudbrick housing. We have seen in examples provided in previous chapters, but also to be discussed in Chapter 9, how this rise in dependence on human-made things involved entanglement and entrapment.

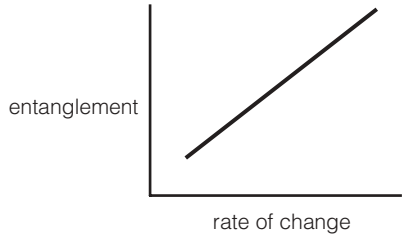
One might have thought that all this dependence on material things made by humans would lead to a decrease in the rate of change. But in fact the opposite happened: rates of change increased. There must have been much perceived daily change in the lives of humans in the Pleistocene, but the rate of observable cultural change often seems glacial. Tool types continued over thousands of years, and the cave art of the Cantabrian and French caves is of a recognizably similar style for at least 10–15 000 years (Valladas *et al.* 2001). In the early tell sites in Anatolia and the Middle East, there is again remarkable continuity, with house built on house over centuries; even the hearths and platforms staying in the same place as seen in the deep sounding at Aşıklı Höyük (Esin and Harmankaya 1999). In PPNA Jericho, there are 32 occupation horizons associated with the monumental tower (Kenyon 1981). Even in the 8th and 7th millennia at Çatalhöyük, there is remarkable continuity.

But there is also change. Detailed anatomies of the buildings at Çatalhöyük show an endless cycle of movement and reorganization. In particular the ovens and hearths and bins keep moving around the building, shifting from one side to the other along the south wall, or being blocked up and shifted into side rooms, and then back into the main rooms. There is an endless restlessness through the sequence of 18 levels as pottery comes in, obsidian becomes more specialized, stamp seals are introduced, figurines change in style, social differentiation becomes more marked, and houses become more independent. In more general terms it is widely recognized that the Neolithic begins to see a faster rate of cultural, social and economic change than the previous millennia.

One can also argue at a much broader scale of analysis that entanglements have increased through time since the Neolithic both in particular countries and globally. Some individuals, countries, nations are more densely entangled than others but

particularly since the industrial revolution we have all become increasingly entangled in one global web. And yet it is apparent to most of us that the rates of change have increased exponentially over the same time period. We saw in Chapter 6 that at the end of the 19th century Europeans were concerned about their individual roles as societies appeared to be disintegrating. In our own times Andy Warhol suggested that each of us would in the future be world famous for 15 minutes, and today events have impacts that seem also simultaneous, spreading in nano-seconds through digital media.

So why is the exponential increase in entanglements positively correlated with the exponential rate of change, especially when we might have expected the opposite?



One explanation that might be proposed to account for the correlation between entanglement and rate of change is that, as we have seen, the production of human life depends on things. Things are needed to mobilize possibilities and potentials. Human physical, economic, social, ideational, psychological and cognitive existence depends on things. It might be assumed that as entanglements increase in scale and complexity there is the possibility of increased production: more resources, more opportunities, more differences can be explored and made use of. There is more energy available to fuel a greater speed of change. While this explanation may have some weight, it is weakened by the fact that increased access to resources need not by itself lead to change. It can equally be associated with limitation, domination and repression by elites that control resources. Another problem is that the explanation is too human-centered in that it assumes that is it human nature to increase production.

And so in my view a more adequate explanation derives from a balanced perspective in which both humans and things play their parts in entanglements. We have seen that entanglements are held taut by dependences, affordances, abstractions, regulations and resonances while at the same time being open, complex, unruly and contingent. Humans are forever working along the various chains and strands in order to fix things as parts of the entanglement get out of step with each other and as things fall apart, run out or start to fail. Things go wrong in unexpected ways and the different entanglements and parts of entanglement are continually coming in relation to each other in conjunctions that seem chaotic and contingent. As they collide and intersect, solutions have to be found. Small parts of the entanglement become untied for a moment and in that opening opportunities emerge.

I suggest that as humans and things get more entangled, and as the strands of the web get longer and denser, so there are more opportunities for things to go wrong. There is also more possibility for the strands to interact with each other in unexpected conjunctions and so to cause catalysis or untyings. In those moments of untying, variation is produced that then gets selected for as the entanglements move on. So entanglement has two components in relation to change. One is entrapment as discussed in Chapter 5. The other is the opportunity for change that is created by greater linking.

Conclusion

I will in the chapter that follows explore the notions of non-teleological directionality and irreversibility with respect to more detailed and fully argued examples. But I have tried in this chapter to consider some implications of entanglement for long-term evolutionary processes. My argument has been that entanglements are open, complex and discontinuous and aspects of complexity theory (despite its human-centered agent-based focus and its tendency to assume universal rationalities) are of value in exploring their workings. Humans and things have unruly interactions resulting from openness, discontinuity and the co-presence of multiple temporalities in social life. There is thus much contingency and uncertainty in processes of change; many unacknowledged conditions and unanticipated outcomes – again at numerous temporal scales. In the conjunctions that result, small things can have catalytic effects as parts of the entanglement are undone. Openings or windows of opportunity are created, and while fixing may often be routine and rule-bound, there is the potential for small events in complex and open systems to have large effects, producing emergent phenomena.

This discussion of catalysis and emergence is of interest in that it seems to offer an explanation for two observable characteristics of the long-term record of human achievement. The first is that the change of entanglements tends to be directional in that it is difficult to reverse human-thing dependences. Reversibility is costly given all the heterogeneous ways in which humans come to depend on things in which they have invested. Often too much has to be undone to go back. The second is that rates of cultural change have increased as the scale and complexity of human-thing entanglement have increased. I argue that rates of change have increased because as entanglements grow in scale and complexity so there is more need for fixing things along the chains and webs of human-thing dependence.

Certainly societies wax and wane in terms of organizational complexity, size and regional or global influence. The cultural sequence in ancient Egypt included intermediate periods of fragmentation and decline between the Old, Middle and New Kingdoms, and the sequence of Andean cultures in ancient Peru is marked by

what archaeologists identify as intermediate periods. After the great expansion of the Roman empire into Europe there were the so-called Dark Ages. But as noted above, societies 'in decline' may continue or even revitalize (McAnany and Yoffee 2010). I have noted above examples of apparent returns from farming to hunting and gathering, but in these cases we do not see a going back to an earlier entanglement. Rather we see the forms of entanglement change. It would be necessary to carry out an analysis of entanglement of the type indicated in the following chapter to ascertain whether intermediate, or dark or collapsed societies really were less entangled than those that preceded them. It would also be necessary for such an analysis to explore whether larger scales of entanglement had incorporated the societies apparently in decline into their orbit. In the chapter that follows I will provide some indication of what such analyses of entanglement might look like.

Chapter 9
Tracing the Threads

The people of Çatalhöyük literally dug themselves into a hole. Chris Doherty has made a conservative calculation that the mound at Çatalhöyük, 150 000 m2 and 21 m high, has a volume of 750 000 cubic meters, equivalent to 1.13 million metric tons. Adjusting this calculation to take into account the organic component of the mound he estimates a clay volume of 675 000 cubic meters. We know that much of the clay for making the houses and other clay objects on site was dug from extraction pits near the mound. If this amount of material was dug from pits 1m in depth, an area would be required equivalent to a square with sides of over 800 m in length. In a series of cores taken from around Çatalhöyük, Doherty and other members of the archaeological team have discovered that there was indeed a very large hole or series of holes that were dug around the Neolithic East Mound at Çatalhöyük (Figure 9.1). This hole was later partly built over by the Chalcolithic West Mound. But the large Neolithic extraction area altered the local environment and affected water flow, run off and colluvium formation on the slopes of the East Mound.

Another effect of the large area of clay extraction pits was discussed in Chapter 4. Through time during the occupation of the East Mound, the prevalence of the reed *Phragmites australis* gradually increased in phytolith assemblages. This proliferation may initially have been encouraged by the digging of pits for clay extraction that filled with water (Figure 4.2). As discussed in Chapter 4 the exploitation of this plant would have had on-effects such as a lowering of water tables and a competitive expulsion of other species, as well as increased human intervention to arrest invasive growth.

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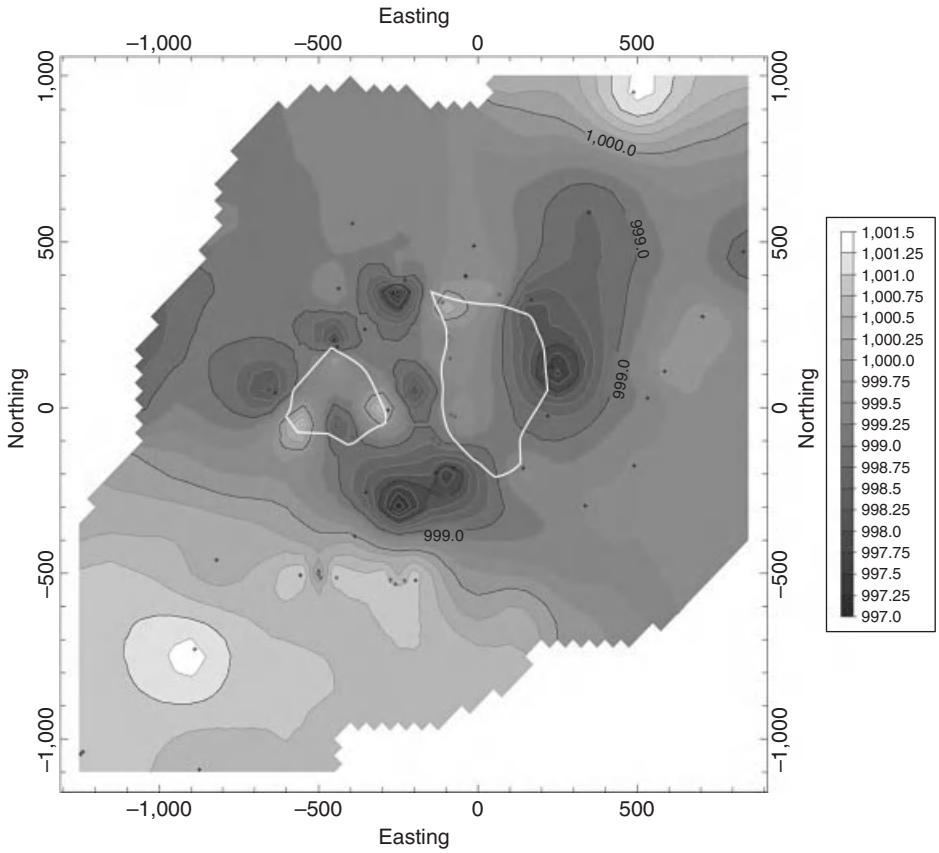

Figure 9.1 Surface of the marl surrounding Çatalhöyük showing depressions around Neolithic East and Chalcolithic West Mounds (the mounds are shown as white outlines) (Source: Chris Doherty).

Tanglegrams

Throughout previous chapters, Çatalhöyük has been used to exemplify the entanglement of humans and clay in the Neolithic of Turkey. In Chapter 3 a simple diagram (Figure 3.2) was used to explore the ways in which the use of clay plasters at the site depended on other tools; an example of things depending on things. In Chapter 4 the use of white plaster in rooms with ovens led to sooting of walls and therefore to the need for an endless cycle of replasterings with new fine white marls obtained from below the alluvium in the areas around the site. In Chapter 6 the replastering of walls was linked to the plastering of human and animal heads as part of the process of memory construction at the site. In Chapter 7 a complex set of entanglements was identified between the introduction of clay cooking pots, the shift towards sandier bricks in house construction and the use of pots for cooking sheep and goat meat and bone.

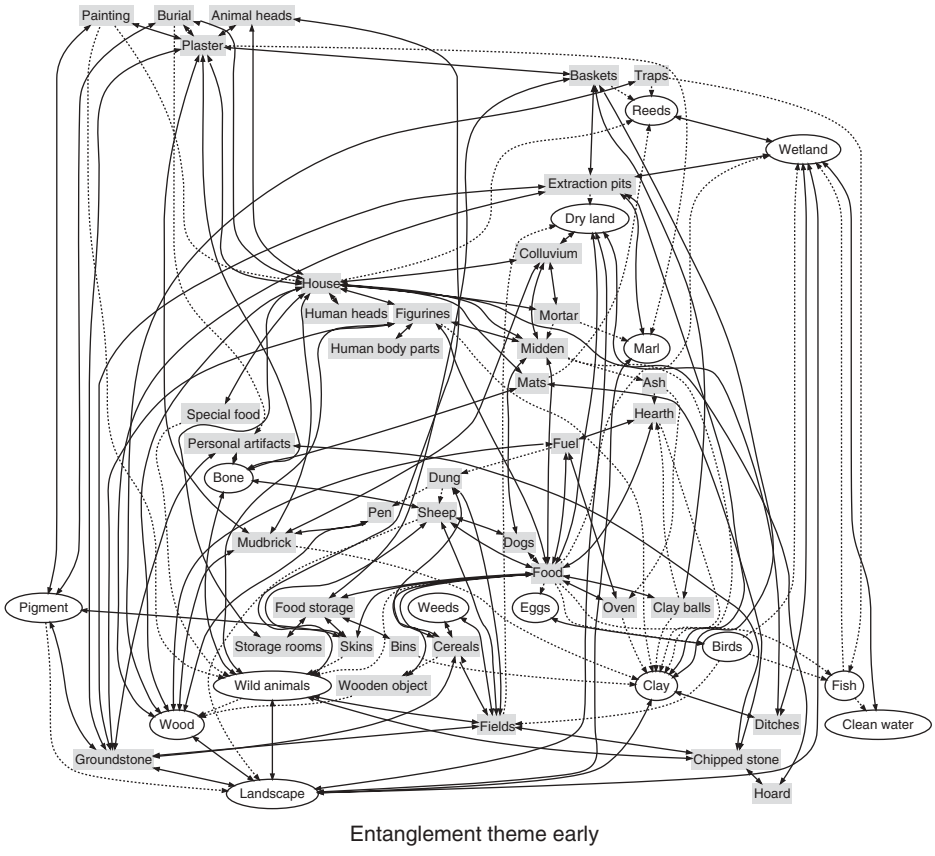

Figure 9.2 Clay entanglements in the first part of the sequence of occupation at Çatalhöyük (Source: the author and Chris Doherty).

These specific instances are just part of a very large and complex entanglement in which clay was situated at Çatalhöyük. Chris Doherty and I have tried to trace some of the threads of this entanglement in Figure 9.2. I wish to discuss this diagram here in order to see whether identifying the threads in past human-thing entanglements in this way can be useful.

The relationships identified in the diagram refer to the earlier part of the sequence at the site. Chris Doherty and I have adopted some conventions in putting the diagram together. Each arrow stands for 'depends on' using one of the definitions of dependence described in Chapter 2. Some dependences are one way. These are often enabling or productive relationships as captured by my use of the term dependence. Thus midden depends on clay (clay or marl was spread over middens, maybe to clean them up or level them) but clay does not depend on midden; mortar depends on midden (midden is the main constituent of much mortar at the site) but midden does not depend on mortar; painting depends on the house (in which it is located) but not vice versa (since houses exist and stand at

the site without paintings); the use of pigment depends on the landscape from which ochres and minerals were obtained but the landscape does not depend on pigments; burial depends on personal artifacts (as grave items) but personal artifacts do not depend on burial (since they were not made especially for burial).

A two-way dependence or co-dependence is indicated by a two-way arrow. These relationships may be mutual dependences but they are often constraining dependencies (as defined in Chapter 2). Thus middens depend on dogs (to keep them clean from vermin) and dogs depend on midden (as space to live in since they were not allowed in houses) but dogs also add to the problem of midden by defecating on them; houses depend on midden (to be clean of refuse) and also middens depend on houses (for the refuse that constitutes them) but middens add to the problem of houses because they build up around houses causing erosion of walls and creating dirt beside houses; groundstone depends on landscape (as source) and landscape depends on groundstone (groundstone axes that cut down trees, etc.) but cutting down trees and obtaining rock change the landscape so that both trees and appropriate rock may be less available; cooking food depends on clay balls (before cooking pots were introduced) and clay balls depend on cooking (otherwise they would have no function) but the type of cooked food that is possible is constrained by the use of clay balls; house building needs wood and trees and it might be thought that trees and wood do not need houses but the persistence of trees in the landscape depends on how intensively this resource is exploited for buildings.

So the diagram is a mapping out of the threads of dependence and dependency surrounding the use of clay at Çatalhöyük. The links are based on interpretations of the material evidence from the site. For example, we know that dogs were present on middens given the large amount of animal bone in the middens that shows evidence of having passed through the gut of some animal. There are few pigs at Çatalhöyük and the bone fragments are too big to have been consumed by humans so it seems likely that the bones had passed through the guts of dogs. We find little deposition of bones that show evidence of consumption by dogs within the houses. And we do not find faecal material inside houses. So it seems likely that dogs scavenged on middens, keeping down vermin there (since we find the bones of mice and weasel and other vermin in and around the houses) but also adding to the faecal material (including human) on the middens. Similar arguments surround the other links identified in the diagram.

Initially in producing the diagram Chris Doherty and I had included humans as a node. But it became clear that nearly everything in the diagram had some degree of dependence in relation to humans. So we adopted the convention of identifying all nodes which were involved in a dependence relationship with humans as filled rectangles, leaving others as open circles. What is immediately clear is the overall dependence on humans as identified in the prevalence of rectangular boxes. Even the nodes that we have left as open circles are affected by humans to some degree. Thus the amount of clay, fish or wild animals available in the landscape very much depends on human action, even if it remains the case that the landscape, clay, fish

and wild animals reproduce without human intervention. The distinction between squares and circles is thus not absolute but a question of degrees of dependence.

An important caveat about the diagram is that it cannot claim to be exhaustive. It is only a very partial mapping. A real-world mapping would be infinitely more complex. As we saw in Chapters 3 and 8, the diagram that I had drawn in Chapter 3 showing the factors involved in lighting a fire can never be complete. In practice lighting a fire takes place in an open system so that other variables not listed or foreseen can always come into play. The diagrams can only be broad schemas for what people do and what they have to think about. They cannot claim to be complete or stable.

One inference that can be drawn from the exercise of producing the tanglegram in Figure 9.2 is that, at least in the case of clay at Çatalhöyük, as one follows the threads of entanglement a very large part of the whole social and material system gets drawn in. We started drawing out the threads that surrounded extraction of clay for building houses but that quickly led to the whole set of entanglements, as might be expected in a small-scale open system. As noted in Chapter 5, in highly complex social-material systems there may be entanglements that are relatively disengaged one from the other. But certainly at Çatalhöyük everything very quickly gets drawn in.

It is also notable that the reasons for the dependences vary. Thus in the diagram, house is shown as depending on human and animal heads because of the role of the house in constructing memory. But house depends on mudbrick or wood as constituents of its fabric. And house depends on mats in order to be kept clean. This heterogeneity is one of the key aspects of entanglement as noted in Chapter 5. Many different components and dimensions of life are co-entangled. There are numerous forms of dependence and a priori none can be given greater causal weight.

Another inference derives from the recognition noted above that so many of the nodes are rectangles – indicating a dependence on human maintenance and action, on human labour and costs. In small-scale hunter-gatherer societies it might be expected that more of a tanglegram would consist of nodes that were self-regenerating or involved in mutual adaptations in which humans were little involved. I would expect that as hunter-gatherers become more complex with greater investments in equipment and managed resources, the tanglegrams would more and more indicate human entrapment. By the time of Çatalhöyük the degree of dependence involving humans is indeed remarkable. The degree to which humans had by this time become involved in the labor of production and reproduction in all directions is striking. As noted in Chapter 8, this degree of entanglement led to both constraint and to a heightened pace of change.

Also very clear in the tanglegram is that some things are more entangled than others. Some nodes have more arrows linked to them than others. These turn out to be the key struts of these particular social arrangements. In the case of Çatalhöyük, many of these relate to environmental features – such as clay, wood, wetland and wild animals. But these highly connected nodes also include early social institutions

such as fields, domesticated sheep and in particular the house. I have argued for some time, as have Watkins and others (Hodder 1990, 2006b, Watkins 2004), that the house was the key social institution at this time – the house was 'the world in a box' (Carter pers. comm.) as everything was brought into it. Zeder (2009) notes a wider regional process whereby storage, for example, is increasingly brought into the house. At Çatalhöyük, in the absence of cult centers, administrative buildings or public spaces the house functioned as the locus for food preparation and consumption, tool production, burial, symbolism and social memory. The house was the key institution of social life (Hodder 2006b). The technique of tracing out the threads of dependence in a tanglegram seems effective at identifying these nodal things and institutions. The centrality of food in the tanglegram is related. One of the main functions of the house was the preparation and provisioning of food, indicated by bins and traces of plant and animal food preparation, the paired hearths and ovens in each house, the importance of feasting evidence in and around houses and the installations in houses of mementos of feasts. In a small-scale house-based society, eating was a central social and political process.

It might be expected then that as things go wrong in an entanglement, and as change occurs, it is these focal nodes that are likely to be the most resilient. They are the most entangled so that more depends on them. Change is likely to be managed so that the key nodal points remain. It is these nodes that are most costly to change so that trade-offs are sought elsewhere in the entanglement before change in the main nodes is tolerated (as discussed in relation to Human Behavioral Ecology in Chapter 4). Indeed, at Çatalhöyük the continuity and stability of the house is remarkable. For century after century the layout of the house and its internal function see little change. Even when radical change does occur, new arrangements are sought that retain the centrality of house, even if it is a house of a different form. In Chapters 7 and 8 I described how after Level V at the site much change can be observed, at least partly linked to changes in the availability of wild cattle. A greater dependence on more intensive uses of domesticated plants and animals is evident associated with a partial unraveling of the focus on ancestors and memories of great hunts and feasts. In all this change, history houses come to be less the focus of ritual and memory and more the focus of domestic production, storage and accumulation. The history house becomes more a multi-functional working 'farm', larger than its neighbours and the focus of competitive consumption and exchange. The nature of the house has changed, but the overall radical shifts in society have been envisaged and structured through the house. The house retains its centrality but in a new form.

Wild animals too have many linkages in the tanglegram in Figure 9.2. Given the nodal role of wild animals, especially wild cattle in the economic, social and ritual systems at Çatalhöyük we would expect that if change in this nodal area did occur there would be far-reaching effects, and this is indeed what happens. Recent work has demonstrated a decline in the relative proportion of wild animals (cattle, equids and boar) after Level VI with a corresponding increase in domestic sheep and goat

(Russell *et al.* 2012). This is a time of major change at Çatalhöyük and it is plausible to link many of these changes to a decline in the use of wild cattle. Installations in houses decline and there is less of a focus on memory construction and continuities between houses (Düring 2006). There is a more intensive use of sheep and goat for secondary animal products and closer management of cattle. A new crop (hulled barley) is introduced and there is increasing enlargement of some houses that become multi-roomed, multi-story and with more space around them for outside activities including hearths, ovens and work areas. In the upper levels of the site pottery becomes more decorated as the shift towards display of production and consumption increases, and burial becomes associated with separate tombs and perhaps cemeteries. All these changes can be understood as linked to the decline in the centrality of ancestor and memory construction in history houses in which feasting on wild cattle were so crucial. So the decrease in the availability or use of wild cattle can reasonably be seen to be an important factor in producing these changes. If a central node has to change, the effects are far-reaching.

Other changes, in less central nodes, have less impact. In the tanglegram, clay balls do not have many links to other nodes. They were made of fired clay and were used to cook food. The food was probably placed in a container such as a basket. The clay balls were heated in the hearth or oven and then placed in the basket to cook the food. Experimental and ethnographic work has shown this method to be very effective (Atalay 2005). In Level VII the clay balls decline in number in the archaeological deposits and are rapidly replaced by cooking pots. The change occurs in Levels VII and VI. The shift from clay balls to pottery in cooking does involve some transformation elsewhere - in sourcing, labor, cooking methods, etc. But as expected, the scale of the change is slight. Hearths and ovens continued much the same (at least for a time) and similar sources of mineral gritted clay as used for the clay balls continued to be used in making pottery. The overall diagram does not change very much as a result of the shift from clay balls to clay pottery.

Locating Entanglements

Drawing out tanglegrams that trace operational sequences and dependences of various types does seem useful in understanding how entanglements work and change. Another way of exploring entanglement is to locate the various components in their spatial contexts. Archaeologists are adept at locating the sources of stones and clay, reconstructing systems of exchange or the locations of fields and trackways, establishing the movements of people around settlements and landscapes. A wide range of techniques from palaeo-economy to the phenomenology of landscapes have been applied to such questions (e.g. Ashmore and Knapp 1999). I wish to provide an example of mapping entanglements at Çatalhöyük.

We have already seen that the digging of clay near Çatalhöyük produced a large hole that would have filled with water and then with colluvium, with multiple implications for plant growth and the availability of local resources. We have also seen that many activities at Çatalhöyük were focused on the house. But how did these houses exploit the landscape and interact with each other? What was the spatial dimension of obtaining clay, plaster, wood, reeds, grazing sheep, hunting cattle and so on?

We are increasingly coming to understand the complex mosaic of resources across the landscape of the Konya plain and surrounding hills and mountains that were exploited from Çatalhöyük. Sheep were grazed over numerous widely-flung environments (Pearson 2012), pottery and groundstone were obtained from the volcanic uplands to the west (Doherty 2012, Wright 2012), shells were obtained from the Mediterranean (Bar-Yosef Mayer 2012) and obsidian mainly from various sources in Cappadocia (Carter and Milic 2012). I wish to focus here, however, on one aspect of this complex spatial network: the dependence of houses on each other within the settlement. After all it was these dependences and dependencies that structured the flow of resources on the mound itself and probably affected how the wider landscape was used.

We can see immediately in Figure 9.3 that the history houses (that is those houses with more burials beneath their floors) in Level VIB in the South Area, are dispersed within the excavated area – there is no central concentration of these special and more elaborate houses. In general terms we have found no evidence of centralization of storage, production, ritual, administration at Çatalhöyük. There is no chiefly residence or area and no ceremonial center. So the spatial organization of entanglement was dispersed. In addition there is much evidence that food storage, preparation and consumption were on a daily basis small-scale. There is limited storage in each house and much evidence for daily processing of plant grains to serve immediate needs. We know that people must have collaborated in working fields and grazing flocks, although the variation in sheep isotopes, including variation between individual houses and parts of the settlement (Pearson 2012), suggests that we should not exaggerate the amount of collaborative labor that was involved in subsistence.

How would houses have responded to risk and uncertainty? Without substantial storage, and with small-scale production and consumption, individual houses would have been very dependent on other houses in times of hardship. How were these dependences located spatially? The mosaic of resources (everything from birds' eggs and reeds to wild cattle and volcanoes) utilized by the community as a whole would have helped to buffer risk. But we can also try and map the social networks through which resources could have been obtained during individual down-turns. For example in Figure 9.3 I have shown houses linked to history houses in which there are many burials. We know that not all the dead buried beneath the floors of history houses could have lived in those houses – in some cases there are just too many burials to have been provided by the inhabitants of the house. We can assume therefore that those houses with few or no burials contributed their dead to the history houses as

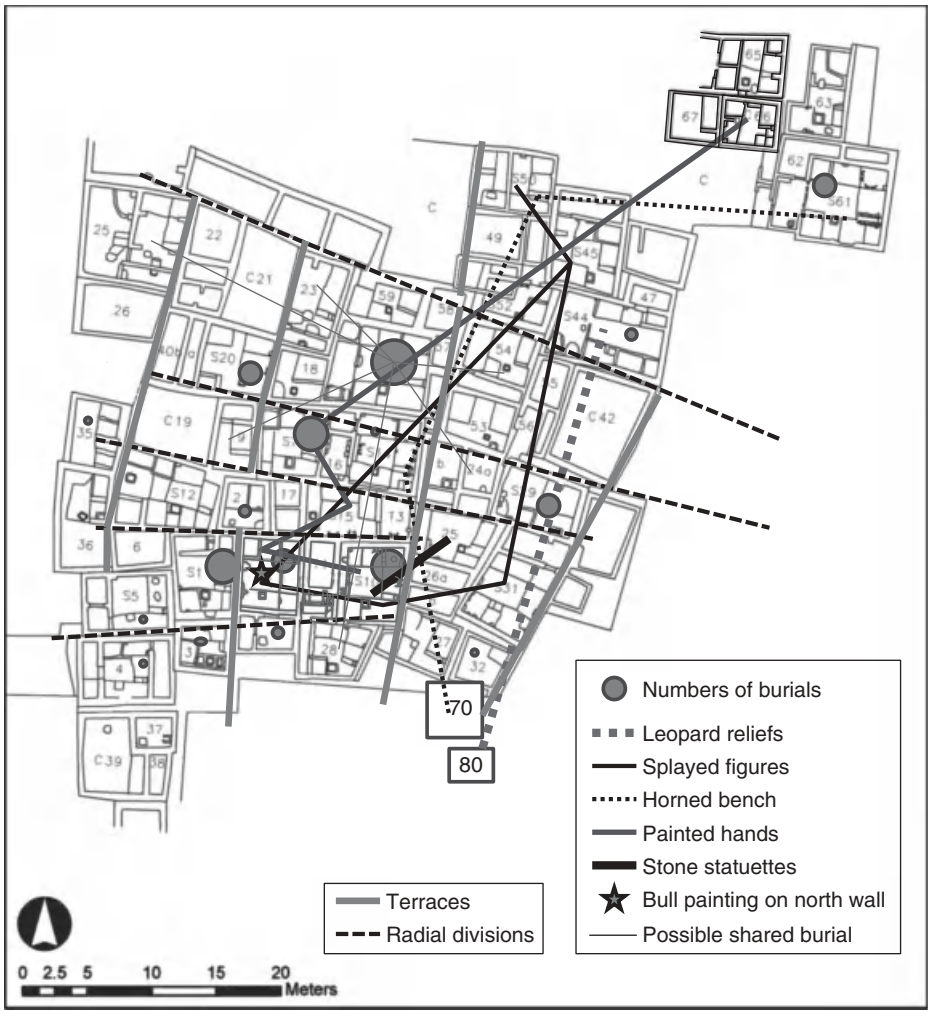

Figure 9.3 The spatial distribution of entanglements at Çatalhöyük in Level VIB. (Source: the author).

shown in Figure 9.3. In other cases we can draw lines between houses that have distinctive cultural attributes. Thus in Figure 9.3 I have drawn lines connecting houses with leopard reliefs. These reliefs are very rare and the inhabitants of the houses with such reliefs must have had some connection – a connection that it might have been possible to draw upon in times of economic hardship. I have also drawn lines between houses that are distinctive because they have benches with bull horns, or hand paintings, or splayed 'bear' reliefs. What we see is that the different networks show some overlap but they do not coincide. The history houses are not central in all domains. The entanglement is not focal or centralized. Rather there is a complex overlapping so that any individual house has multiple possible relationships that it can draw upon in times of hardship.

The spatial dimension of Çatalhöyük entanglements is yet more complex. The settlement is divided into two halves or hills, which are themselves divided into sectors separated by lines or zones of midden (Hodder 2006b). But within these sectors there are radiating lines that start at the top of the mound and extend outwards. For the Level VIB settlement in the South Area these radial lines are shown in Figure 9.3. The lines separate groups of houses that are distinctive. Some of the radial zones have more elaborate houses than others, and some become midden areas at certain points during the occupation of the mound. So again, it seems likely that houses within a radial zone could call on each other in times of difficulty. But cross-cutting these radial zones are terraces. As one moves from the top of the mound down its slope, the houses are organized into terraces at decreasing height. These terraces are also marked in Figure 9.3. Perhaps these too acted as a group of houses on which individual houses could at times depend.

So the end result, shown in Figure 9.3, is highly complex. The mapping suggests a dispersed overlapping mosaic of relationships. The implication is that a person or house could get food (or obsidian or wood or clay) from people on their terrace, in their sector, in their burial group, in the group of people that have bears or leopards on the walls, in their bull-feasting group, in their neighborhood and so on. This type of entanglement allows individual units to depend on small-scale agriculture and to invest little in storage. The diversity of resources creates sustainability, but equally the complexity of the entanglements creates a dense network of dependences that can be drawn upon when needed. This is a form of 'social storage' (Halstead 1981, Halstead and O'Shea 1989) but it is more than that. The heterogeneous mosaic itself creates resilience and stability. Indeed, the rate of change at Çatalhöyük and related sites such as Aşıklı Höyük is remarkably slow, even if speeded up in comparison to earlier Palaeolithic times. For example, the plants and animals exploited at Çatalhöyük remained remarkably consistent over at least 1000 years. This was a highly stable and successful society, perhaps mainly because the complex heterogeneity of its entanglements proved resilient as things went wrong.

Note that it is the tensile strength of the entanglement as a whole or the large amount of overlapping and redundant interactions that underpinned stability and resilience. The material conditions of life did not determine the persistence and durability of the system. Certainly technologies and production of food played a central role. Humans at Çatalhöyük shared food, exchanged obsidian, worked together in fields. But it was not this alone that maintained stability and buffered risk. It was equally the exchange of the dead, the joint feasting on wild bulls, and the participation in art and symbols. It was the heterogeneous linkages themselves that underpinned society and produced resilience.

The shelter that has been constructed in the South Area at Çatalhöyük has very slight foundations (Figure 9.4). We did not want to dig many deep foundation trenches to hold up massive metal pillars placed at frequent intervals across the excavation area as these would have harmed the archaeological deposits and made further excavation difficult. So the roof was constructed in such a way that it could

Figure 9.4 The roof structure over the excavations in the South Area at Çatalhöyük (Source: Çatalhöyük Research Project and Jason Quinlan).

rest on a shallow concrete belt around the edge, leaving the central area free. In order to do this the roof was constructed of multiple struts to produce a steel-frame truss system. In the end the roof was held together by the tensile strength of all the conjoined members. The roof holds itself up rather than being held up by numerous uprights. In the same way, the tensile strength of the mosaic of connections in the entanglement at Çatalhöyük resulted in a highly stable economic web. The tensile strength of the entanglement itself created the stability. I do not want to argue that the superstructure held up the base. As we have seen, the entanglement is redundant and heterogeneous, as much economic base as ideological superstructure. Rather it is the entanglement that holds itself together while allowing accommodation as things go wrong, run out or decay.

Sequencing Entanglements – at Çatalhöyük

Entanglements are tied to spatial matrices, but they are also tied to multi-scalar temporal matrices of various kinds. In particular I wish to distinguish between (i) operational step-wise sequences, (ii) life histories of things, (iii) historical sequences of categories of things, and (iv) legacies.

(i) Various types of operational sequence were discussed in Chapter 3, including *chaînes opératoires* and behavioral chains. Tanglegrams can be organized according to the sequence of operations that are needed to achieve some end or purpose. There is a temporality to human-thing interactions. We have to wait for one step to be completed in a productive process before we can proceed to the next step. Often archaeologists focus on the stages of procurement, production, exchange, consumption, discard and so on. But at a tighter scale archaeologists can often also tease apart the various components of each

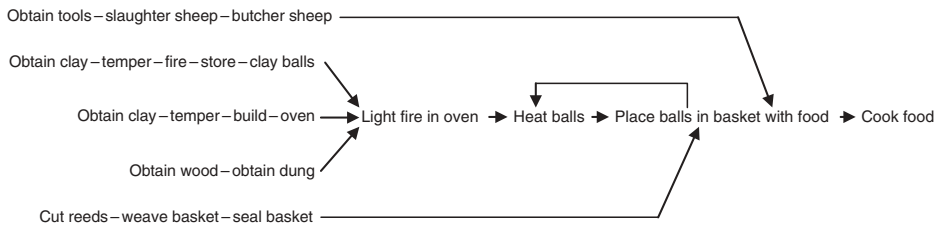
Obtain tools – slaughter sheep – butcher sheep
Obtain clay – temper – fire – store – clay balls
Obtain clay – temper – build – oven
Light fire in oven
Heat balls
Place balls in basket with food
Cook food
Obtain wood – obtain dung
Cut reeds – weave basket – seal basket

Figure 9.5 The sequence of steps involved in using clay balls to cook sheep meat in a basket at Çatalhöyük (Source: the author).

of these stages. Thus in Figure 9.5 I have identified some of the steps involved in using clay balls to cook sheep meat in a basket at Çatalhöyük. First an oven or hearth has to be constructed, dung and wood obtained. Perhaps during the same period the clay balls have to be made and the baskets woven and prepared. Then the fire can be lit and the balls placed in the fire. When heated they are removed with wooden tongs and placed in the basket with uncooked meat and liquid. When they cool down the balls have to be returned to the fire and replaced with hot balls. The process continues until the meat is boiled.

It is of interest to compare this operational sequence with that involved in boiling or stewing meat after the introduction of cooking pottery. The production process of the pot itself adds complexity, involving considerable skill in the forming of thin-walled vessels that will not crack and break. But there are savings in that baskets are not needed and, most significantly, there is not the need to continually return items to the fire to reheat. Whether it is attractive and effective to use pots in this way will partly depend, as I argued in Chapter 6, on the other things going on in the house at the time. But the major increased entanglement is that pottery came to be obtained by exchange from volcanic areas to the west (Doherty 2012), involving the provision of items as exchange gifts and the maintenance of exchange relations.

Sequences of operations also have to be set within the seasonal round of other activities. As Flannery (1968) noted in reference to early Mesoamerica, the introduction of domestic maize would have had an impact on other resource procurement. The scheduling of the collection of a wide range of plants would have been disrupted as humans devoted time to the tending of this one crop, thus forcing an ever greater reliance on maize. Archaeologists are often able to use seasonal indicators (migratory birds or animals for example) in order to identify the parts of the year in which sites were occupied, and they are able to use knowledge of growing cycles in order to reconstruct the seasonal pattern of activities at a site. The evidence from Çatalhöyük suggests the scheduling shown in Figure 9.6. The complex interlacing of operational sequences is clear, and these temporal interactions constitute a key component of entanglement. Evidence from sequences of oxygen isotopes in the teeth of domestic sheep has been studied by Elizabeth Henton so that time of birth of the Çatalhöyük sheep

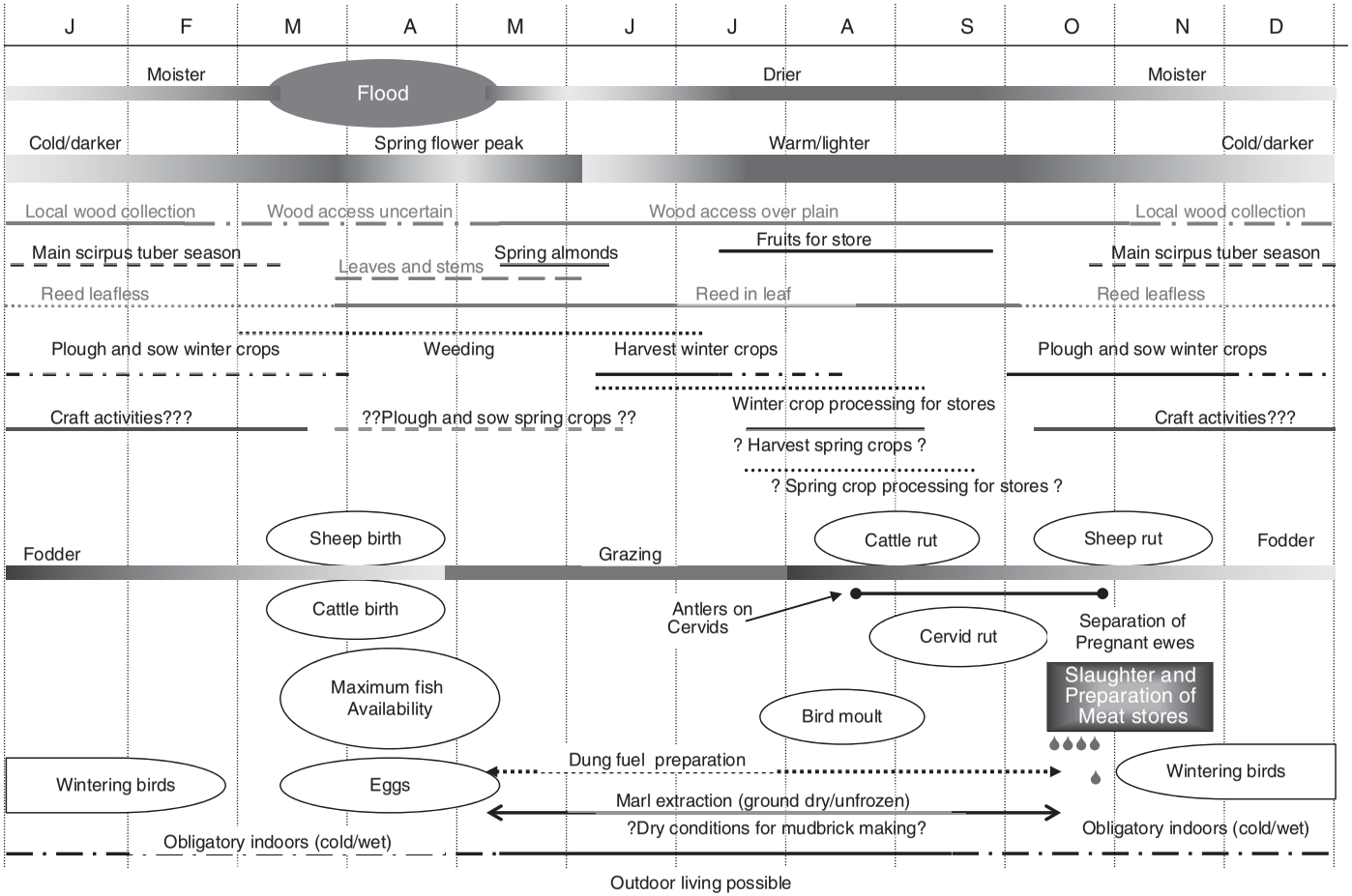

Figure 9.6 Reconstruction of seasonal activities at Çatalhöyük (Source: Fairbairn 2005).

can be identified. Henton (pers comm) shows that in the earlier levels at the site sheep tended to be born in April to July but in the later levels more were born in March. This earlier birthing suggests manipulation of the herds (since wild sheep in the area today give birth later) and it indicates the provisioning of fodder during the winter months, which itself implies the storage of fresh hay. The harvesting and storage of additional grasses would have increased pressure on the already very busy periods in the summer and autumn when labor-demanding activities such as crop harvesting, slaughter and preparation of meat stores, obtaining and storing fruits, collecting wood from across the plain, making of mud bricks and plastering walls took place. The increased pressure on this summer and autumn period caused by the early birthing of sheep may explain why in the upper levels of the site we see a decreased frequency of replastering of walls inside houses. Plaster in these upper levels is less white and is thicker, less often replaced. This shift to a new, less labor-intensive plastering regime may have been a trade-off to lessen the labor requirements in the summer and early autumn.

(ii) A second scale of sequencing of entanglements concerns the life histories of specific things. Individual items go through processes of production, use, re-use and discard and the study of traces on things in order to reconstruct these sequences has been widely developed in archaeology. The scientific analytical techniques have been well developed and increasingly anthropological and materiality theories have been applied to the study of artifact life histories. Much of this work returns to the seminal work by Appadurai (1986) on the social life of things, but more recently there has been an interesting focus on artifacts as they become memories and markers, re-signified in changing social contexts. At Çatalhöyük there are many examples of bone artifacts being repaired and re-used (Russell 2005) but perhaps the best examples of things with long and complex use lives are human skulls and other parts of the human skeleton. A body may be initially buried entirely complete and fleshed. It may then be moved to a secondary burial. The skull may then be removed. The skull may itself be painted or plastered to re-create human features. The skull can then be deposited, for example at the base of the posts holding up a house (Hodder 2006b). The circulation of body parts and the creation of life histories or biographies for these artifacts are central components of the creation of history seen across the site but especially in the history houses.

(iii) As for the third scale of sequencing, study of the historical sequences of categories or types was described in Chapter 7. Much evolutionary archaeology has developed methods for the tracing of genealogies of types based on various measures of affinity and association. I argued in Chapter 7 that increases and decreases in types (battleship or spindle curves) needed to be situated within the entanglements that made them possible. Types and traits persist to the extent that they are 'fitting' within entanglements. I described the decrease in the use of clay balls at Çatalhöyük and the concomitant increase in cooking pottery. The shift from clay balls to cooking pots needed to be understood as a solution to problems that needed fixing. So rather than just plotting the frequencies of types (upper part of

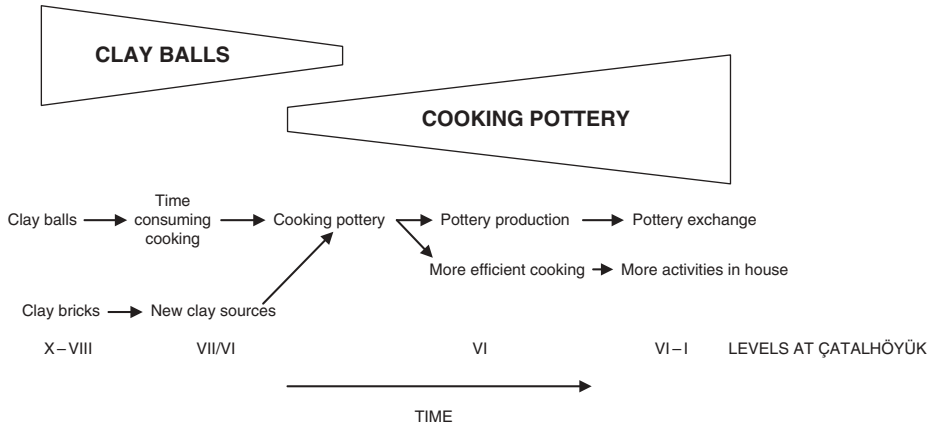

Figure 9.7 Sequences of types (clay balls and cooking pottery) set within a decision-making environment at Çatalhöyük (Source: the author).

diagram in Figure 9.7), the sequence of balls and pots can be set within a decision-making environment (lower part of the diagram).

(iv) By the fourth scale of sequencing, legacy, I refer to the ways in which things have their own temporalities that stack up around the present. Things hang around or die out. These active temporalities influence how humans and things behave. How humans respond to the residual stuff around them can tell us a lot about how a particular society is organized. The 'house' at Çatalhöyük was a social-material institution but it was also a thing with its own temporalities and its own spatial presence. The material house constituted and enabled the social house. But there was also a dependency constraint resulting from differences in temporality. For example, the house had unstable walls and needed constant tending. In addition, the house was most stable if built on the stubs of earlier walls. Once a house had been started, there was a tendency for all later houses built above it to have the same shape, regardless of circumstance. We can see this with regard to a building in the 4040 Area at Çatalhöyük. This house has a dog-leg in its northern wall. There is no contemporary need for this dog-leg; there is no adjacent house to avoid. But the dog-leg follows the outline of earlier houses in which packing had forced this unusual shape. Thus the shape of the house in one level is a legacy of the shape of houses in earlier levels – all because houses were more stable if built on earlier walls. Or put another way, all subsequent rebuilds of houses used the same walls.

The posts that helped to hold up the walls of the houses were very carefully curated. Difficult to obtain given that the oak and juniper from which they were made grew in the mountains to the south and west, the posts were always removed from buildings during abandonment to be re-used in later houses. The use-lives of posts extended over many generations (see Figure 9.8). Human skeletons too were sometimes dug up from earlier houses and redeposited as secondary burials. It is likely that cooking pots lasted several years; whereas wall-plasters seem to have been

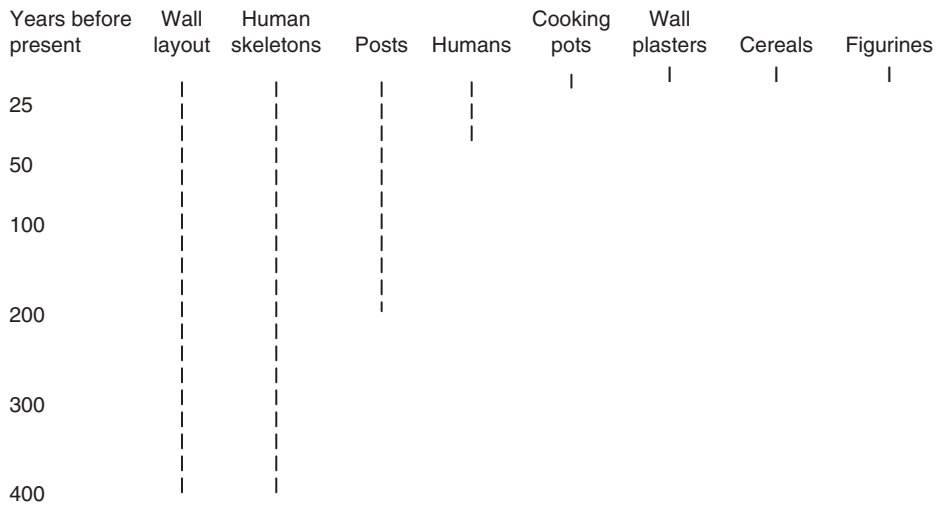

Figure 9.8 Legacy diagram for Çatalhöyük showing differential persistence of things (Source: the author).

renewed every few months. Cereals were stored and were processed on a daily basis for immediate consumption. Figurines seem to have been used and discarded quickly.

So we can build a legacy diagram which identifies the duration of things and humans in the house at Çatalhöyük. The layout of house walls, the burials beneath the floors, and the wooden posts of oak and juniper constituted a legacy that was made good use of in the particular context of Çatalhöyük. In fact all three were given special symbolic load as part of the construction of histories. The construction and dismantling of walls were carefully managed and often embedded within ritual. The upright posts were plastered and often affixed with installations such as wild cattle horns and heads. The human skeleton was at times dug up and used in the construction of histories (in the circulation of skulls for example). The everyday things of shorter duration and legacy seem to have carried less of a social and symbolic load at Çatalhöyük. Figurines were quickly made and discarded in midden. Food preparation and cooking pots were not surrounded in symbolic elaboration (the pots were undecorated as were ovens and bins). The short-lived wall plasters, on the other hand, were sometimes painted but this activity could have been an embellishing of the walls beneath the plasters rather than of the plasters themselves. In different societies material legacies are dealt with in different ways. At Çatalhöyük material legacies were important in constructing histories in a house society. Other societies may place more emphasis on the daily negotiation of things without legacy. A potential research aim is to explore these differences, and understand them in relation to degrees of entanglement.

Archaeologists have long been fascinated by legacy in the form of residuality. Look at the dates on the coins in your wallet. You will find that you may have few from this year, but most of the coins will be from recent minting. A few, however,

might be very old. If we count the frequencies of coins of different dates in a wallet or in an archaeological deposit, they usually decrease with increasing age. The reasons for variations in levels of residuality have been discussed with reference to particular sites (Evans and Millett 1992) and with reference to economic systems and coinage circulation (Reece 1984). The shapes of residuality curves are linked to processes of circulation, value, curation and deposition. Some forms of entanglement absorb greater amounts of legacy and residuality than others, but this remains an area in which little archaeological research has been conducted.

Sequencing Entanglements – the Origins of Agriculture in the Middle East

Daily social life is laced through with entanglements that stretch out spatially and temporally. Some of the temporal sequences cover very long time periods. I wish to argue here that the origins of farming and settled life came about in the Middle East as part of a long-term process of entanglement.

The origins of agriculture in the Middle East are normally explained through various types of event or specific cause – most commonly climate change at the start of the Holocene, population increase, changes in the availability of resources, feasting and social differentiation or the emergence of new symbolic or cognitive systems (Belfer-Cohen and Bar-Yosef 2000, Bender 1978, Byrd 1994, Cauvin 1994, Flannery 1972 and 1993, Hayden 1990, Hole 2000, Renfrew 1998).

Animals, plants and artifacts produced by humans during this transition are usually seen as indicators of change or as technologies allowing adaptation. Childe (1951) described a Neolithic 'package' of traits, and in the years since his writing there has been much discussion of how the various elements in the package allow more intensive resource exploitation, sedentism and community building. But the things themselves and how they drag humans into dependences have been less well studied. In Chapter 4 I discussed work that explores the behavior of plants and animals and examines the specific ways in which humans are drawn into their care.

Zeder (2009) has recently documented the timing of the introduction of the 10 elements of Childe's Neolithic package. It is now clear that the 10 elements were introduced at very different times (see Figure 9.9). (1) An agricultural economy based on ***domesticated plants and animals*** was introduced slowly over many millennia, with many phases of intensive herding and cultivation before the appearance of genetically altered domesticated forms in the 9th millennium BC (Nesbitt 2002, Weiss *et al.* 2006, Wilcox *et al.* 2008, Fuller *et al.* 2010); (2) various surveys (e.g. Henry 2002, Kuijt and Goring-Morris 2002) of settlement size and density have argued for ***population increase*** from the Natufian through the Pre-Pottery Neolithic; (3) Childe argued for the importance of ***storage*** of surplus and while storage is evident from the Natufian onwards there remains in my view no evidence

that this storage was used to create social surplus during the early Pre-Pottery Neolithic in the Middle East; (4) ***sedentism*** had certainly become common by the early Natufian (12 500–10 500 BC) although examples may occur earlier as at Ohalo II (Nadel 2004); (5) ***trade*** networks for shells and obsidian expanded across the region from the Natufian onwards; (6) ***communal social institutions*** are evident by the Natufian at 'Ain Mallaha and Hallan Çemi; (7) associated ***magico-religious traditions*** are evident at Göbekli Tepe in southeast Turkey in the 10th and 9th millennia BC (Schmidt 2006); (8) ***ground stone*** implements appeared by 24 000 years ago and were ubiquitous by 12 000 BC; (9) true clay ***ceramics*** appeared at 8000 BC in Iran and had reached across to central Anatolia by 7000 BC; (10) ***weaving*** implements in the form of spindle whorls appeared by 7500–7000 BC.

But it is possible to see these elements of the agricultural revolution not as a package but as an entanglement. Over a long period of time the elements became tied to each other, dependent on each other, but also channeling change in a certain direction as events happened and problems emerged that needed fixing. For example we can take the case of ground stone. Grinding, often associated with

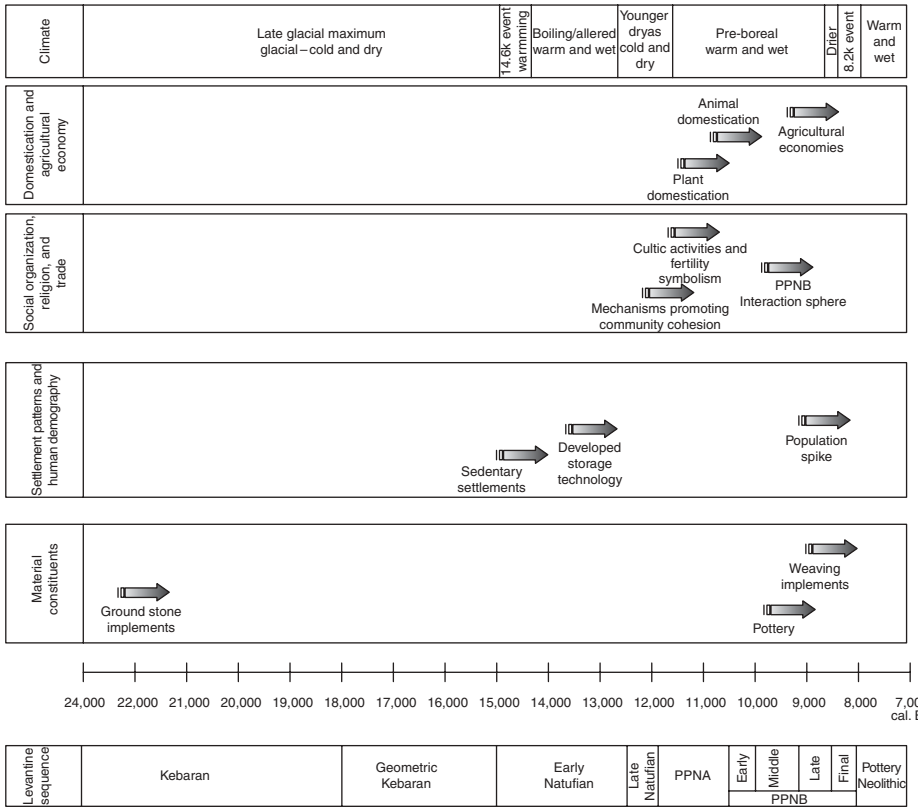

Figure 9.9 The timing of the introduction of parts of Childe's Neolithic 'package' in the Middle East (Source: Zeder 2009). With kind permission from Springer Science+Business Media.

other processing and cooking, makes the nutrients in many foods more accessible and may remove toxins (Wright 1994). Starch grain analysis of ground stones from Ohalo II shows the grinding of wild barley and other grasses (Piperno and Wiess 2004) at 21 000 BC. The prevalence of grinding stones increases gradually through the Epipalaeolithic and they are common in the Natufian and Pre-Pottery Neolithic. Their occurrence is functionally tied to increasing population, increasing settlement size, increasing sedentism and increasingly intensive cultivation and dependence on wild grasses. Indeed, grinding stones made early agriculture possible and channeled adaptations in the direction of increased intensification of plant use.

Grinding stones also 'structured the way in which foods were prepared and consumed, leading to breads, pancakes and other batter products' (Fuller and Rowlands 2009: 23). In the Middle East the main domesticates (wheat, barley and rye) all contained the protein gluten and thus they could be made into leavened breads. An entanglement between grinding stones and cereals containing gluten led to a bread-based foodway that has continued to today.

In the processing of both wild and domesticated cereals pounding is needed at a late stage (see Figure 9.10) in order to remove husks and spikelets from grains.

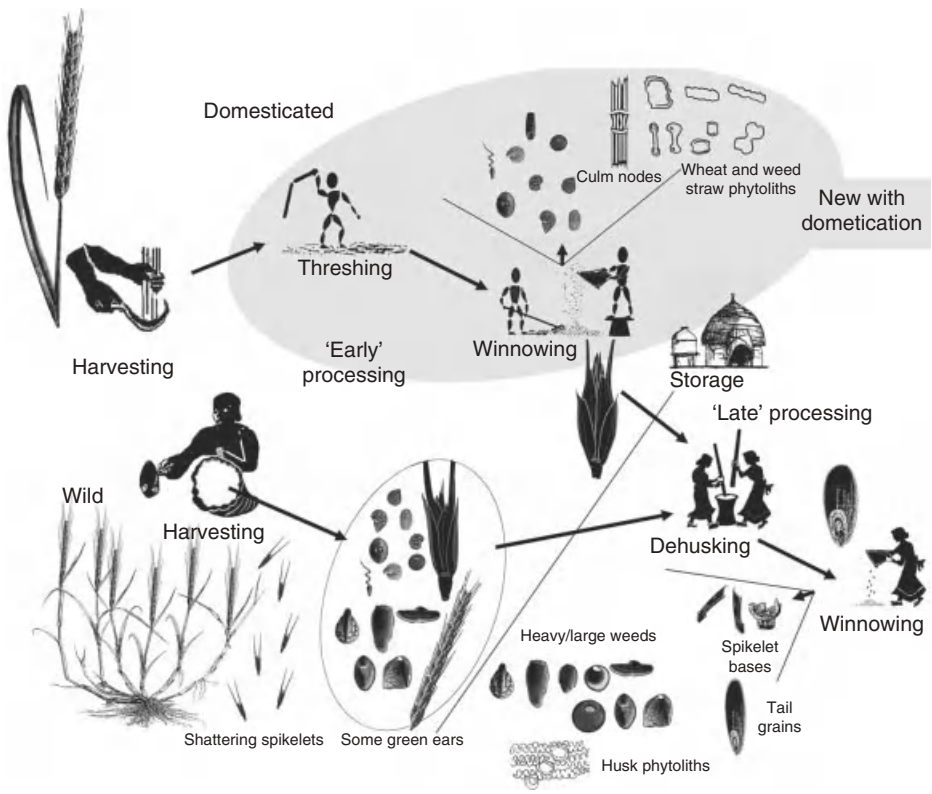

Figure 9.10 The processing of wild and domesticated cereals in the Middle East (Source: Dorian Fuller).

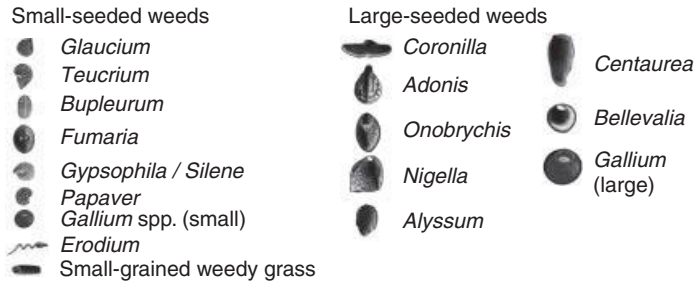

Figure 9.10 (Continued).

The diagram is based on wild and domesticated emmer but is representative of any glume wheat (einkorn, new-type).

Weeds taxa are selected to be illustrative and not comprehensive, based on the taxa from Middle Euphrates sites like Jerf el Ahmar, D'jade, etc. published by Willcox *et al.* 2008. Small seeded grasses are put as weeds with the domesticated harvest and not in the wild harvest on the inference that these might have used as food more often in the wild harvest contexts, as inferred at Ohalo II, Abu Hureyra 1. Phytolith morphotypes included are not comprehensive but represent the types that are most likely to be useful for considering crop-processing ratios.

This diagram assumes that some or all wild harvesting is done by paddle and basket methods; this is method assumed by Hillman, and is widely reported ethnographically for wild grain harvests (North America, Africa, Australia, wild rices in India, etc.). Others (e.g. Willcox) would contend that most wild grain harvests in the Near East were by sickling of green ears. This method would increase the proportion of green ears and reduce, but not eliminate loose spikelets; it would increase the mature loose spikelets that fell and were added to the wild seed bank of harvested stands. If green ears are thoroughly dried they should still disarticulate without major threshing efforts, and basic contrasts would be more or less the same. Both basket and sickle method might have been used if we assume that there was variation among households and communities. Such variation, and experimentation, in practices would contribute to a slower overall rate of change in cereal morphology (on rachis shattering) and indicate different local forms of entanglement.

Ethnographic and experimental data have shown that dehusking is best achieved using wooden pestle and concave mortar (Wright 1994). Grinding with flat stone querns and handstones reduces the particle size of the grains and so exposes more starch to enzymes during digestion, permitting more nutrients to be absorbed by the gut. Further grinding to produce flour enhances the process. Ethnographic and experimental research has shown that although grinding increases nutrient uptake, the processing costs are considerable in terms of grinding hours per calorie

(Wright 1994). In addition we need to take into account all the costs of obtaining and making the grinding stones themselves. Grinding stones are usually made of hard and heavy igneous or metamorphic rock. The stone has to be quarried in slabs or blocks and then pecked or otherwise worked into appropriate shapes. Grinding stones wear out and need replacing. All such activities hinder the mobility of hunter-gatherers and encourage decreases in mobility (Wright 1994).

In the Middle East, already by the Kebaran (20 000–14 500 before present) 'some mortars are too large to have been routinely transported' (Wright 1994: 249). In the Natufian there is a marked increase in prevalence of ground stones, especially mortars and elongated pestles. The increase in ground stone appears centrally linked to population increase and more intensive plant production, while at the same time helping to produce greater sedentism. As humans became tied down by the extra labor of processing plants and obtaining and making ground stone they became increasingly tied to place. In the PPNA, ground stones are yet more prevalent but there is a shift from mortars and pestles to querns and handstones (Wright 1994). This shift probably suggests a greater emphasis on reducing particle size and the production of flour but at the expense of greater processing time – both in grinding the grains and in making and maintaining the grinding stones used to prepare them.

Grinding stones were also involved in social and symbolic life in the Middle Eastern Neolithic. They were used to grind ocher for paints (Wright 1994). Sculpted pestles (with goat or bird heads for example) have been found at a number of early sites such as Hallan Çemi and Nemrik 9 (Rosenberg and Redding 2000, Kozlowski 2002) suggesting the entanglement of pestles in metaphors and abstractions. Mithen, Finlayson and Shaffrey (2005) have convincingly argued that stone pestles in the southern Levant have phallic associations. The pounding of food may thus have resonated with sexual activity and had symbolic associations with the phallocentric emphasis in much early Middle Eastern imagery (Hodder and Meskell 2011).

We could extend the analysis of different types of entanglement sequences to all the other components in Childe's 'package'. In fact the different parts of the 'package' are entangled in complex webs that gradually thicken and become more complex over time. As we have seen storage is evident from at least Natufian times and must have been intimately connected to grinding and grain processing for a wide range of plants. The introduction of pottery for cooking would, in its turn, have enhanced nutrient uptake from plants while at the same time increasing labor (in the manufacture and trade of pottery); ground stones were often used to burnish the surfaces of pottery to increase their efficiency in cooking (Schiffer 1990, Schiffer *et al.* 1994). Chipped stone was traded over long distances for a variety of functions including the sickles used in harvesting wild and domesticated grasses. The winnowed residues from the harvested grasses were mixed with mud to increase the strength of the houses; PPNA daub or pisé (at Jerf el Ahmar) was found to contain wild cereal chaff including spikelets in considerable quantities (Willcox and Fornite 1998). So, within building material, grasses contributed to sedentism in yet another way.

Overall, then, the 10 components of Childe's package became increasingly entangled with each other over a very long period, starting at least by 20 000 BC. We know some of the things that 'went wrong' in this period and needed fixing. For example, as discussed in Chapter 8, the climatic deterioration of the Younger Dryas at 10 800 to 9500 BC led to a dispersal of settlement in the Late Natufian and a temporary return to more mobility. We can assume there were many later events that needed managing, including the leaning and collapsing of brick walls and the build-up of refuse. Each fixing seems to have involved greater entanglement. Using daub and then bricks depended on the cutting of grasses in greater quantities or in new ways. Such cutting may have competed with or enhanced the use of grasses as a food source. Either way, human entanglement with grasses increased. The genetic changes in plants that we call domestication are frequently seen as unintended consequences of increasingly intensive plant use. But I argue here that the increasingly intensive plant use was entangled within a particular trajectory in which grinding stones, gluten, chipped stone, bricks and humans were all tied together.

Causality and Directionality

Note that none of this needs a prime mover such as climate change or increasing population. All it needs is for small things to go wrong every now and then. So let us say that around 12 500 BC at the start of the Natufian in the Levant a small semi-mobile group has started investing in ground stone to process plants of various types. Wright (1994) has documented the increase in ground stone use in the Natufian as opposed to earlier periods. The increased use of ground stone has allowed the group to gain more nutrients from plants and given areas of land. The extra labor required to grind plants and to make grinding stones helps push up population density in the area. This population increase may have led to shifts in hunting. Stiner *et al.* (2000) have shown that from the Middle Palaeolithic to the Natufian in the Levant humans gradually shifted their acquisition of small game towards animals and birds that took more work to acquire. In particular they started focusing on agile small game such as birds, rabbits and hares. In the Natufian the increase in efficiency of plant nutrient extraction may have been entangled with more costly small game hunting.

Let us further say that this semi-mobile group increasingly dependent on ground stone moves away from the source of ground stone. A problem has been presented that needs fixing. In deciding what to do, various trade-offs have to be considered. One solution would be to go back to the exploitation of less costly small game, decrease population levels and nutrient requirements and decrease the need for grinding stones. But of course all this would take time – to restock the area with slower-moving and less costly small game, and to decrease human population

densities. The temporalities of things (the breeding cycles of animals and humans) have rather trapped humans so that they cannot go back. All humans can realistically do is seek other solutions – all of which involve further intensification, further dependences between humans and things. One solution would be to become more sedentary – to stop moving away from the ground stone sources. This of course requires many shifts, material, social and ideological. Another solution might be to enter into exchange relations with those living by the sources of stone, but that too involves costs (in the provision of goods for exchange) and may be unreliable. There will also be abstractions and resonances surrounding the social and symbolic roles of pestles that would influence decision making. But whatever the specific solution, there will be a tendency to minimize disruption to other parts of the entanglement. It will be more 'cost-effective' to minimize disturbance elsewhere in all the dependences. But these 'cost-effective' solutions usually seem to involve more work, more intensive dependences, more entanglement.

I am arguing then for a long term view in which towards the end of the Pleistocene humans were drawn into greater entanglements with things and thus with each other, forming larger communities and more intensively husbanding resources so that they could sustain the things (crops, fields, grinding stones, exchanges of goods) on which they had come to depend. In this scenario population increase, settlement stability, domestication of plants and animals are all just offshoots of a very general process in which humans and things depend on each other, humans fix things when they go wrong, and thus increasingly invest in things in which they become entrapped.

If this was so then we would expect the same process worldwide, with local variations depending on specific environments and cultural contexts. And indeed this is what we find. If we take a broad, global, view, it can be argued that sedentism, intensification and some degree of social consolidation or differentiation occur very widely in the early Holocene. This point has been restated by Diamond (1997). Many areas of the world show these traits. Some are associated with agricultural origins – in the Fertile Crescent, China, Mesoamerica, Andes/Amazonia, eastern United States, Sahel, tropical West Africa, Ethiopia, and New Guinea. But in many other areas, the same or similar effects are produced through the intensive use of 'wild' resources. In the Holocene, hunter-gatherers developed sedentary village life with increased population densities, complex material culture, and in some cases pottery and ranked societies in several areas such as Mesolithic Europe, Japan and maritime Far East Asia, the North American High Arctic, the Pacific coast of northwest North America, interior California's oak woodlands, the California Channel Islands, the Calusa of Florida, the coast of Ecuador, and the Murray-Darling Basin of southeast Australia. There is a broad social process which happens to involve early agriculture in some areas.

Many would also argue that there was a widespread population increase in the early Holocene. The Neolithic Demographic Transition (NDT) has been recognized in many parts of the world in increases in site sizes, numbers and

density and in changes in the proportion of immature skeletons in cemeteries (Bocquet-Appel and Bar-Yosef 2008). The specific evidence for an increase in population in the southern Levant is discussed by Kuijt (2008b) and there appears to be considerable variation in the timing and consequences. While population increase is often seen as the cause of social, economic and cultural change at the start of the Neolithic no universal relationships have been found and the direction of the causal arrow is often difficult to determine.

One general implication of the NDT that is often claimed is a decline in health (Cohen 2008). Worldwide there is much variation in the timing of a decline in health and of the domestication of plants and animals, and yet surveys of skeletal data often conclude that health suffered during the early Holocene transition (Larsen 1995). Cohen (2008) attributes the decline to diminishing returns for labor as humans switched to smaller game and small seeded plants leading to domestication. Diminishing returns are defined by Cohen in terms of caloric returns per hour of labor.

It is widely recognized that another general trend in the early Holocene is an increase in things made by humans. This increase is normally seen as a result of sedentism (Rollefson 2008). Renfrew (2001:128) argues that 'human culture became more substantive, more material' as a result of sedentism, population growth or more intensive resource acquisition. Usually the increase in material culture is seen as a secondary offshoot of these other developments. I would like to turn this argument round and suggest that the overall global process that we observe was not caused by population increase, climate change, domestication or sedentism – but rather that all these things were the products of a long slow process of increased entanglement between humans and things. We have seen that the package of Neolithic traits in the Middle East was stretched out over millennia. In addition to the package identified by Childe there are other changes that involved greater investment in things – such as the adoption and proliferation of multi-component arrowheads or the building of larger and more stable (including brick) houses. As humans became increasingly dependent on things they had made, including things that needed care and maintenance and came to depend on humans for their propagation, so they had to find ways of fixing things and problems as they arose. It was rarely possible to go back, and so humans became involved in a cycle of greater dependence on things, often requiring new technologies or more labor. The demand for labor would have produced a higher birth rate leading initially to population growth. To return to the example of ground stones, the need for constant grinding of food would have encouraged increases in family size. We can say the same about hunting more costly small game, or later making bricks or firing pottery. But as more people invested more in more things so they became more trapped by things, running faster to stay in the same place. In many places health declined and signs of stress emerged.

I have delved briefly into this large scale global view in order to make the point that entanglement provides a general framework in which change in human

societies comes about as a complex process in which there are no set causal factors and much depends on the specific conjunctures that bring people and things together in specific historic contexts, and yet there is an overall direction. I discussed this directionality in Chapter 8, but I have used the example of the 'adoption of farming' or the 'Neolithic' in order to demonstrate how specific sets of data might be explored within such a framework.

It is important to emphasize, however, that beneath the general trends there are specific multi-scalar sequences and interactions that can be studied effectively with the entanglement approach. In particular I have used the example of Çatalhöyük to demonstrate the more well-grounded arguments that can be traced in the evidence. Certainly at Çatalhöyük it cannot be argued that greater densities of humans in large settled communities led to stress and poor health. The skeletal data from the site have shown remarkably good health of the population. And yet the site was densely packed with large accumulations of refuse (middens), full of human and animal faeces, rotting bones and reeds and so on. Clearly the inhabitants of the site had found ways to manage the site so as to minimize disease and ill-health. I discussed in Chapter 4 the 'garbage crisis in prehistory' (Hardy-Smith and Edwards 2004). And certainly dealing with the build up of refuse in sedentary communities became a major issue by the PPNB in the Middle East. But at Çatalhöyük the middens were managed. They were leveled frequently, often covered in burnt material or lime-rich ash and clay. These specific entanglements and solutions need studying before we can usefully build robust global models.

I have argued that no cause or single event led to the domestication of plants and animals. I also argue that, at the large scale being considered here, no choice or intent was involved. Certainly in the daily local problem solving, as things went wrong and had to be fixed, there was much choice, intent and agency. But at the scale of the overall direction of change towards increasing dependence on things made by humans, increasing intensification, population growth, sedentism and domestication there was no overall directional intentionality that somehow remained stable for over 15 000 years.

It is now widely accepted that plant domestication in the Middle East was unintended (Fuller *et al.* 2010). It was the result of a long build up of increasingly intensive use of plants starting at least with the use of ground stones (by 21 000 BC) and involving over the next 12 000 years more thorough processing, different modes of harvesting, the emergence of storage, sowing, ground preparation and so on (Fuller *et al.* 2010). All these interventions in plants and cereals had to be in place before the conditions allowed for the selection of non-shattering cereal genes. 'The crop domestication process includes several distinct but entangled processes, some of which have an inevitability about them: unintended consequences of interactions between humans and proto-cultigens. We have referred to some of these consequences as 'traps', as they result in human farmers having to expend extra effort, e.g. on crop-processing or maintenance of soil fertility. This probably implies that, compared to their ancestors who made the very first steps in cultivation

or who were hunter-gatherers, farmers became increasingly entangled into more labor demanding food-production regimes. The domestication pathway involved several 'tipping points' of intensification. This is so because morphologically domesticated cereals require more labor, both in terms of investments in cultivation (the soil nutrient trap) and in post-harvest labor (the crop-processing trap). The payback for this, however, is increased reliability in harvest and increased yield, and more controllable (owned) resources' (Fuller *et al.* 2010: 23).

However much active intentionality was involved in increasingly intensive uses of materials, plants and animals in the period leading up to full domestication in the Middle East, there was no teleology of heading towards the Neolithic. Rather, the directionality towards domestication was a by-product of the tendency to fix things within existing entanglements and within the taut web of dependences.

Conclusion

I have wanted in this chapter to indicate the fruitfulness of the concept of entanglement. By using examples of the many ways in which we can analyze the threads of entanglement I have tried to show the potential for new methods, interpretations and explanations. It seems possible to trace out entanglements in terms of function and dependence, but also spatially and through time. Many different types and scales of temporal, historical and operational sequence can be opened up for study. There is the potential for new approaches to the tenacity, persistence and change of societies.

It might be argued on the other hand that the approaches exemplified in this chapter are simply versions of existing perspectives. The focus on temporal sequences has parallels with the lineages discussed in various forms of evolutionary theory (Chapter 7), and there are also obvious parallels with the networks explored by Latour and Actor Network Theory. As argued in Chapter 5, entanglements differ from actor networks in the focus on forms of dependence. The approaches used here are similar to network analysis as applied to the 'pull' of nodes within a settlement system (Knappett, Evans and Rivers 2008). Approaches combining insights from graph theory, social network analysis, statistical physics and geography are effective at exploring the behavior of complex networks (Evans, Knappett and Rivers 2007). They model dynamic networks that evolve so as to minimize the 'costs' of their maintenance, in much the same way that I have argued that entanglements adjust in order to minimize disruption, but they model links between nodes very simply, without the emphasis on forms of dependence that are the foci of this book. Nevertheless it would be of great interest to apply network models not to spatial relationships but to entanglements of the type shown in Figure 9.2. I have not as yet developed quantitative models for the analysis of tanglegrams and entanglements

but there is clearly potential for quantitative analysis based, for example, on the relative trade-off costs of different pathways through entanglements (as defined in Chapter 4 in relation to experimental and ethnoarchaeological data, similar to Behavioral Ecology models) or on the analysis of complex networks.

The discussion of entanglement sequences in this chapter might give the impression that entanglement always produces gradual change. But we also saw in Chapter 8 that the complex interactions between humans and things can lead to untying as much as to stability. The untying can be sudden, leading to new unanticipated and emergent phenomena. Above I used the metaphor of a trussed roof that has tensile and self-supporting strength. But a rather different metaphor can be used. Imagine a whole group of skaters of various skills holding on to each other as they move slowly over the ice. Shoulder to shoulder they hold each other up and support those that slip and stumble. But if, at a particular conjuncture, it so happens that a large number of the skaters slip over together, suddenly the whole crowd might be downed. We saw in Chapter 8 that bifurcations and rapid transformations can occur in complex systems and I provided some historical examples. While claims have been made for punctuated events during the shift to farming in the early Holocene (Zeder 2009), the evidence is scant; on the whole people held themselves up very well as the Pleistocene ice melted! But we should not assume that stability is the norm in other cases.

Chapter 10
Conclusions

The thing has been associated with a malevolent 'biological materiality that is or may be the result of our unknowing (usually atomic or nuclear) intervention into nature, the revenge of the blob … which imperils man.'

(Grosz 2001:167)

It is matter, the thing, that produces life.

(Grosz 2001: 168)

The key claims in this book have been the following:

- Entanglement is the dialectic of dependence and dependency between humans and things (Chapters 2–5).
- Central to human-thing entanglements are the temporalities of things, their scheduling and sequencing; things have to be done in a certain order (Chapter 3).
- Entanglement is compounded by conceptual abstractions and bodily resonance, a reverberation between mind, body and the world of things (Chapter 6).
- Entanglement occurs between humans and all things but the physical processes of material things contribute an entrapment, stickiness and practical messiness (Chapter 5).
- It is not the material conditions of social life that determine the direction of change but the tautness (the entrapment) of heterogeneous entanglements (Chapter 5).

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- Human-thing dependence is unstable and unruly (humans and things have vitality) leading to processes of untying (catalysis) in which emergent phenomena appear and fixing solutions are sought (Chapter 8).
- Things evolve and transform because they are fitting within particular entanglements (Chapters 6 and 7).
- We dig ourselves into holes as a result of the tautness of entanglements so that overall there is an irreversibility to entanglement (Chapter 8).
- The concept of entanglement allows a fuller integration of the humanities, social sciences, biological and material sciences in the study of things; entanglements are heterogeneous (Chapter 5).

My aim in this conclusion is to draw out some issues that are raised by this list of propositions.

The Object Nature of Things

Most people writing about 'things' nowadays focus on the topics I covered in Chapter 2. These topics are within the domain of social theory, material culture studies, materiality, memory and the like and there are increasingly sophisticated and persuasive studies (e.g. Mills and Walker 2008). I have argued that these approaches often pay little heed to the biological, chemical, physical thing. Most of this book has tried to move beyond the confines of material culture and social theory in order to incorporate mechanical, molecular things with their own temporalities and interactions with each other. I have wanted to take the object nature of things seriously, not to return to materialism and ecological determinacy but to seek a fuller account in which heterogeneous things and people are entangled in each other.

Many of those working in material culture studies have taken inspiration from Hegel's writing on the 'Phenomenology of Spirit' (e.g. see Miller 2010). An example often given is Hegel's account of salt. There are many attributes of salt, including that it is white, tart and cubicle. The perceived unity of the salt as a thing is pulled apart in the experience of its various different properties. The chemical and physical properties of the salt play a part in Hegel's discussion of perception as a dialectical process of unity and difference, but in material culture studies the vast scientific developments in the understanding of matter since Hegel's time are largely ignored. The molecular structure of salt ties together its whiteness, tartness, shape and weight, in much the same way that Keane (2003b) argues that material co-presence bundles concepts together. Adequate understanding of this material bundling, gathering and assembling needs to involve the analytical sciences, including archaeometry.

A key concern of this book has been to find ways to integrate archaeological and material science into a scientific archaeology of things and humans without

descending into the object/subject debates and oppositions. In Chapters 3–4 I described thing dependence on humans and on other things. The main perspectives involved were from the material sciences and from behavioral research. These approaches are central to any attempt to break out of a human-centered, social-centered approach, but the difficulties with them are that they easily become reductive and ecologically or materially determinist. In Chapter 5 I argued that entanglement – as a heterogeneous mix of humans and things, potentials and constraints, ideas and technologies – avoids subject/object, material/ideal dualisms. Entanglement is a mix of humans and things, culture and matter, society and technology.

The determinative component in entanglements that pushes them in certain directions is not the economic base, the ecology nor the infrastructure; but neither is it ideology, systems of meaning nor the superstructure. Rather the entangling itself has a tautness that channels and directs humans and things as they go about their daily business of dependence and co-dependence. In Chapters 6–8 I explored this tautness as a heterogeneous fittingness. When things go wrong (as they always do, at some point or other), fixing has to occur relationally, in ways that are fitting with respect to the rest of the existing entanglements. Entanglements have a momentum and direction deriving from fittingness and also from the temporalities imposed on humans by things. Because of the human investment in and dependence on things it becomes very difficult to disentangle and to go backwards. Through time we dig ourselves into the hole of car dependence, cattle dependence, clay dependence. As we fix things within these holes, there tends to be a directional movement.

While this book has been about entanglement, much of the discussion has been about the core notion of dependence. This term has proved useful in identifying some key components of the relationships between humans and things, because it has a dual or dialectical meaning. On the one hand, we have seen humans depending on or relying on things to achieve goals (dependence). This is the enabling part of the human use of tools and symbols in order to form the subject, society and adaptation to environments. This is Grosz' productive thing quoted at the start of this chapter. On the other hand, we have seen dependency and co-dependency when humans and things cannot manage without each other and, in this dependency on each other, they constrain and limit what each can do. This is the potentially malevolent destructive aspect of things as identified by Grosz. These two components of dependence, positive and negative, produce and constrain human action and lead humans into entanglements from which it becomes difficult to become detached. Because humans rely on things that have to be maintained so that they can be relied on, humans are caught in the lives and temporalities of things, their uncertain vicissitudes and their insatiable needs. Things appear as Hydra like, requiring Herculean skill to stop them multiplying and entrapping, and yet the entrapment is enticing and productive.

The material strings that tie us often seem invisible. They only become visible when we run into problems – as we are now with global warming. Our entrapment

in material webs often occurs because things have different temporalities, often very long term, and we take them for granted or we forget history or we cannot predict how complex systems will respond. We do not know what to expect and when. Then suddenly a wall falls down, or cattle are realized to be producing too much CO^2, or the Millennium bug appears. Or at Çatalhöyük the socially 'invisible' domesticates come to the fore as other parts of the entanglement shift (see Chapter 5). It is at these moments that our material entanglements are revealed, are recognized and are dealt with.

It could be argued that I have given too much weight to the vibrant nature of things. Surely it is an exaggeration to say that things are always falling apart, always changing and drawing us into their care; all that is solid does not melt into air. When we wake up each morning the house is still there, there is sugar on the table for the breakfast cereal, and the milk for the cereal is still cold in the fridge, the car is still in the garage and we can drive to work, the streets are still in place, and in the end the plane gets me to my destination, usually. And when something does go wrong, surely I can deal with it because on the whole I can trust that all the other things I need to fix it will be stable enough to get the job done. On the whole, is it not the case that self and society depend on the stability of things?

My main answer to this objection is that yes, things do seem stable on the whole. But this is because we are, or someone is, working very hard to produce that stability. We depend on the sweetness of the sugar, and the electricity to work the fridge, and the milk in the cereal, and the car and the plane containing petrol. But in order to produce this ready-to-handedness, this everyday expectation of stability and order, a vast apparatus of humans and things has to be mobilized on a global scale. To get the sugar to the table, to maintain the electricity grid, and to assure supplies of oil involves massive mobilization of resources, humans, dependencies. Things have lives of their own that we get drawn into and society depends on our abilities to manage this vibrancy of things effectively, to produce the effect of stability.

The notion that things are unstable is, from one perspective, the product of modern physics. For Newton matter consisted of a stable mass and the forces that set mass in motion through attraction and repulsion. But Einstein showed that mass and energy can be converted into one another and so can be seen as equivalent (Coole and Frost 2010). We now see matter as made up of atoms that are very active, with a positively charged nucleus surrounded by spinning electrons. At a lower level there are protons, quarks, leptons and so on. So at the atomic and sub-atomic level we see that matter 'becomes' rather than 'is'. And at large scales, complexity and chaos theory suggest that the natural environment is more complex and unstable than was thought, with unpredictable and non-linear effects (Coole and Frost 2010).

Recent work in philosophy and the social sciences has come to similar conclusions (Bennett 2010) and there are descriptions of new materialisms that explore the ways in which matter 'becomes' (Coole and Frost 2010) within complex social-material worlds. Perhaps the best example of the argument

about things and humans in motion in this book is the human riding a bicycle, where both human and thing launch each other into joint movement and depend on each other to keep things going as they are. So the focus is not on things and humans themselves but on their joint movement, that leads to unanticipated consequences that act back and create new problems and conditions. So I need to keep turning the wheels, keep adding fuel to the fire I have lit, keep working at maintaining supply lines to sugar and oil, keep earning to pay for access to the electricity grid, keep protecting my investments in the house. I have to keep moving to keep it all in place. In order to do this I often become increasingly dependent on the labor of others, and on energies provided by things and their interactions. These energies may be productive but they also produce constraint and increased expenditures of energy. We are drawn into protection of supply lines, procurement, new methods of manufacture, forms of maintenance, managing discard. We often manage to live relatively unaware of the full complexity of what and who provides us, but we are nevertheless deeply entangled in the vitality of things and the assemblages of their relations (Collier and Ong 2005).

Too Much Stuff?

In Chapter 5 I provided a simple formula for entanglement in which I took a fourth term HH (human-human dependence) for granted. Human interaction and sociality are of course the domains of much of the humanities and social sciences. HH dependence again involves dependency. It would be possible to turn the structure of this book around and argue that we should start with HH dependence and see all other forms of dependence in which things are involved as simply extensions of HH relations. It is in the HH realm that dependence has been best studied. We know that humans are primarily social animals and that in the early development of the child there is an immediate attraction to human faces, voices and nourishment. It might be possible to argue that our psychological and social dependence on things is usually a metaphor or replacement for relations with humans. We would prefer to have a human friend rather than a motorbike to help deal with depression, or we would prefer people to recognize our status and identity without having to use things. It is not material things that entrap us into relationships with people, but it is our debts and obligations to people that entrap us into relations with things.

However there are some problems with this argument. First, dealing with things is not the same as dealing with humans – people often prefer to deal with things precisely because they are not humans. There may be a security and an apparent predictability about dealing with things. Throwing a ball between depressed teenagers may at some moments be a more effective way of building confidence

in social interactions than talking. Second, much of what things do for us is not doable by humans – tools and machines precisely do what humans cannot. HH interactions depend on the other three types of dependence (HT, TH, TT) and it is the complexity of these dependences that produces entanglement. It has not been my aim to under-estimate the importance of HH relations, but these relations often enlist the other three types of dependence and as a result humans are embroiled in things.

But perhaps I have over-emphasized the object matter of things because it is in my interests, as an archaeologist, to foreground material 'blobs'. In our societies, it is archaeologists who have been charged with dealing with the material weight of the past. It is they who are aware more than most that things lie around in their own temporalities, suddenly coming to the surface, getting in the way of roads, quarries, housing developments so that they have to be dealt with. It is archaeologists who see most clearly how an objective material heritage entraps us. The world of heritage, museums, conservation and preservation is a good example of entanglement. Is all the theory I have discussed in this book only of interest to that small number of people whose job is to organize and regulate and systematize old things as they come to the surface? Is entanglement just a theory based on vested interest?

Certainly all theory is situated, but there are many influences other than the archaeological that lead to a focus on the object nature of things. I discussed the 'return to things' in the social sciences and humanities in Chapter 1. But there are also significant factors outside academe that make us all increasingly aware of 'the revenge of the blob'. Most important may be the 'limits to growth' indicated by the material facts of global warming; or the constraints produced by the global availability of oil. There is also the brute force of terrorism and 9/11 that has come to limit us. Alternatively we can take a very different tack and point to the ways in which increasingly we live our lives in virtual e-worlds or engaged in distanced social messaging. In such a context there may be a nostalgic desire to return to hard, 'real' tactile things. I argue, then, that entanglement theory is of wide relevance and that the foregrounding of material 'stuff', not just as material meanings and social processes but also as matter that affects us, is a key part of an adequate social theory.

It may also be helpful at this point to restate my claim that while asserting the importance of material stuff I have not been arguing that human action is determined by material necessity and by the practical connections between things. My focus has been on flows of matter, energy and information, but the starting point in Chapter 2 was a human dependence on things that entailed cognitive, emotional, nutritional, technological and other dimensions. My starting point has been human need, even if we have also seen that need and desire are awakened by things in a dialectical affordance. Human dependences on things lead to human dependencies; the resulting entanglements are heterogeneous rather than materially determinative.

Temporality and Structure

The concept of entanglement as I have described it in this book is fundamentally about time. Amongst those that study systems or networks, the analytical focus is on the relationships and links between nodes, how they interact and feed back in positive and negative ways, how increasing population leads to increases in technology and pressure on resources ameliorated by ideologies and social structures and so on. The entanglement focus is different, or rather it adds to system and network the notion that the links between nodes involve temporal duration. The links are not just links, but involve debts and duties and investments. They involve schedules and bottle-necks. They involve humans waiting for things to happen and becoming involved in the duration of things and their processes. This focus on the temporal weight attached to nodes and links is captured by the terms dependence and dependency. In origin, the word 'depend' means to hang down (also the source of the word pendulum), and so the term can be used to refer to the ways in which things are weighed down in temporal duration. The nodes in a system or network are not free. They are weighed down by commitments, ownership, consequences and conditions. They 'depend' in the sense of being contingent in time. They involve productive dependence and constraining dependency, and in both cases there is a temporal weight as humans are caught in thingly interactions. There is something that endures beyond the flows, networks and systems. It is this heterogeneous something that I have tried to capture by the term entanglement.

The focus in this book has been on the thing-in-motion, both humans and things caught in a co-movement which cannot be reversed. I described the reasons for entrapment in Chapter 5, but overall the most important factor is that once we have invested in things in a particular way the co-movement makes switching paths very difficult. For example, by buying a house together two people have invested money, self, identity, status, time, effort. It is not so much that there is a structure of law that determines how to act, although that too exists, but it is more that the buying of a house together has a temporality. There are upstream and downstream effects since decisions made about the house purchase (such as what type of mortgage to get) and the house itself (when the roof will need repair) influence and limit decisions made down the line. Whether one can sell the house again in the future affects decisions made about whether to redo the roof.

The temporal weight of dependence is perhaps interpretable in terms of the notion of structure as used in the social sciences and humanities. Structures are often interpreted as rules, regulations, codes, embodied ways of doing. All these forms of structure, discursive or non-discursive, institutional or cultural, are often seen as historically produced and transformable through human agency. In this book all 'structure' is made up of webs of dependences and dependencies that lean forward and backwards, dependent on earlier investments and decisions and looking forward to expected outcomes. The gift of objects involves expectations about

the return of the gift, about the full or partial transfer of ownership. Joint ventures in labor and maintenance involve duties and obligations. Procurement of materials is related to use, maintenance and discard down the line. Ownership is not a static category: it has to be worked at (see Chapter 2). We are always waiting for things to happen (Chapter 3). And they wait for us too (Chapter 4). The 'structure' then, is the emergent outcome of specific human-thing entanglements.

Earlier accounts of structure and agency (Bourdieu 1977,Giddens 1979) identified unacknowledged conditions and unintended consequences. The entanglement approach as construed here draws this focus on uncertain conditions and consequences from the margin into center stage. In his account of entanglement, Thomas (1991: 9) argues that the symbolic world is 'practically muddled like everything else' and he refers to the messiness and practical contingency of colonial encounters. Out of the muddles of entanglements new alignments and relationships are formed that tie humans and things into new dependences that have temporal duration and weight. These apparent structures are emergent and spontaneous bundles or assemblages of humans and things. It is the tying together within dependence that produces what we call structure. And this tying together is also the product of and makes possible power and agency.

Power and Agency

The terrain of entanglement is not flat and some entanglements are more entrapping than others. Although the tanglegram in Figure 9.2 is two-dimensional, there are concentrations of links, high-points of dependency and troughs between. When plotted spatially as in Figure 9.3, we can again explore the concentrations and discontinuities. The spatial mapping of entanglements at Çatalhöyük is relatively egalitarian, but a similar plotting at many other sites and in many landscapes would identify nodal points (chiefly centers, imperial capitals, dominant metropolises) around which dependence and dependency are aligned and controlled. On all forms of landscape the 'taskscapes' are differentially distributed (Ingold 1993) as are 'ethnoscapes', 'mediascapes', 'technoscapes', 'finanscapes' and 'ideoscapes' (Appadurai 1990). In all such cases, the peaks and troughs have much to do with the differential distribution of access and the unequal relationships between dependence and dependency. In short, they have much to do with power.

It might be argued that I have paid insufficient attention to the workings of power in my account of entanglement. I have rather taken power differentials as implicit in dependency and in ownership, obligations, duties and regulation. And yet power has been a constant theme ever-present within entanglements as I have described them. Humans depend on things (HT) in order to build, maintain and justify power. They depend on things to control others. Power makes use of the flows of meaning and energy in things, their associations and relationships.

In terms of TT dependences, things are at the heart of the creation of relative value and the construction of forms of exchange and capital. Power is constrained by technologies and the availability of materials. In terms of TH dependences, the unruliness of things and their complex temporalities entrap humans into forms of care and maintenance, so providing a raison d'être for inequality and social constraint. I have emphasized that entanglements look different from different social positions and in relation to different interests (for example, the different views about which part of a sailing boat are important), and power is often or always concerned with which situated set of entanglements should dominate over others. Power is the differential flow of matter, energy and information through entanglements.

The temporalities of things and the unpredictable conjunctures that occur between them ('events dear boy, events') can enhance or erode power differentials, whether we consider the oil that stopped lubricating the guns of the invading German troops in the freezing cold of a Russian winter in Operation Barbarossa (Chapter 5) or whether we discuss the drop in the availability of wild cattle in the upper levels at Çatalhöyük (Chapter 9). It seems appropriate to critique the network theories of Actor Network Theories as being relatively unconcerned with power. But as I made clear in Chapter 5, entanglement is not just about networks – it is particularly concerned with dependences. As such it is immediately and directly concerned with power.

Human power to achieve goals and gain dominance over others leads to human-thing entanglement as resources are mobilized, ownership asserted and access restricted. But equally, forms of power are produced within particular forms of entanglement. Enduring structures of power are emergent phenomena produced within dense and complex sets of relations and dependences (Coole and Frost 2010). The entanglement of humans and things in the slave trade (guns, slaves, sugar, enabled by bigger, faster ships) became associated with appalling inequality as dominant groups protected their investments and coerced others into dependency relations with them. Entanglements can be productive and distributive but also viciously unequal, destructive and disempowering. The perspective provided by entanglement is that such power relations are not just about control of the means of production, or the control of social relations or social ideologies since those mechanisms of control are themselves set within wider human-thing entanglements. Today globalization is increasingly explored by anthropologists as a specific intersection of technology, politics and ethics. Collier and Ong (2005:12) argue that global power relations can be understood in terms of 'heterogeneous, contingent, unstable, partial, and situated' assemblages.

In the master-slave relationship the chains of the slave are produced within particular forms of entanglement and entrapment. Clearly, however, master and slave are differently situated within entanglements. Dominant groups have access to greater resources, networks and dependences. They work to protect their investments and to channel change in the direction of their own interests. In such

a context slaves have little access to the flows of energy, material and information within entanglements. They are entrapped within the entanglements of others. Elites become entrapped in dependency relations that have to be maintained, are often fragile, needing to be worked at. They tend to pursue change that reiterates their position of control, but in the end wider shifts (in the case of slavery these involved hard-fought changes in attitudes as much as in technologies, economies and politics) may undermine or transform their control of humans and things.

In the extensive debates in the human and social sciences regarding human agency, there is broad understanding of the ways in which humans manipulate things in order to resist domination, transform meanings, undermine authority and power, create identities and sustain notions of personhood (Dobres and Robb 2000, Fowler 2004). We also increasingly recognize that the identification of agents and individuals is culturally variable (Gosden 2005, Meskell 2004, 2005b, Strathern 1999). Similarly, the mapping of entanglements involves detailing the potentialities available to humans in social action and describing the constraints within which they can work. The flows of matter, energy and information within entanglements make social life possible but they also entrap humans into various forms of dependency. And certain types of entanglement produce specific types of agent and individual. In the upper levels at Çatalhöyük there seems to be a heightened awareness of a separate self (Hodder 2006) and the pounding chords afforded Beethoven by new steel-framed pianos elicited a new romantic individual in the nineteenth century in Europe.

The study of agency contributes to the analysis of entanglement, but the emphasis in entanglement theory is less on the agent itself and more on the networks of entanglement that make possible and constrain certain forms of agency and certain forms of agent. There is not just a human subject creating agency but a distributive agency consisting of a 'swarm of vitalities at play' (Bennett 2010: 32). Agency is simply the ever-present force of things: the life force of humans and all organic things, and the forces of attraction, repulsion, etc. of all material things and their interactions. We are ourselves part mineral, produced by the flow of things through us. Humans have a particular form of life force, but all things are vital or vibrant (Bennett 2010). Within this heterogeneity, humans exert a problem-solving agency that finds fitting solutions that take into account many trade-offs and relative costs. In particular at catalytic moments, there is a partial untying of the knots of entanglement and there is much uncertainty of outcome. At such moments there is greater potential for individual actions to have far-reaching consequences, leading to bifurcations and radical transformation. Agency is intimately tied to the state and trajectory of entanglements.

Actor Network Theory is identified with the extension of agency to things. According to Latour, things can delegate for humans and in doing so they have an impact, an effect, and an agency even though there is no intentionality involved. In Chapter 2 I mentioned the work of Gell distinguishing primary human agency involving intentionality from the secondary agency of things that act for humans.

I agree that things have a secondary agency as described by Latour and Gell, that is an agency given to them by humans. But I argue that in their objectness things also have primary agency. In this volume, I have tried to show that things have a primary agency, not derived from humans and not associated with intentionality. Rather, things have primary agency in that they act in the world as a result of processes of material interaction, transformation and decay. Materials and the forces that flow through them afford humans certain potentials and constraints. In these ways things are actors.

To and from Formulaic Reduction

We could reduce many of the arguments in this book to simple formulae. For example, we could say that

$$E + \text{problem} + \text{fix} = E^n$$

(where E is entanglement and $n > 1$)
or

$$\text{Increase in dependence} \Rightarrow \text{Increase in dependency}$$

(where $\Rightarrow$ means 'leads to').

Another way of making much the same point as the last formula, is to argue that a solution that is less costly in locale A, may be more costly elsewhere and thus in E as a whole. Thus

$$E(\text{locale A}) + \text{problem} + \text{fix} = E(\text{total})^n$$

All these three formulae express the tendency for entanglements to increase in scale and complexity as things go wrong. I came across an example of the last formula recently when buying a fluorescent lamp for a wall fitting that had blown. The type of fluorescent lamp that I bought saves energy in my house when compared with traditional light bulbs. So at locale A (my house) I save energy. But I cannot throw the fluorescent lamp in the garbage because it contains mercury. I have to take the lamp back to the shop for special disposal. The instructions on the lamp packet say 'Dispose of according to local, state or federal laws'. Costs have been shifted elsewhere in the entanglement – amongst other things to garbage disposal and regulatory procedures. Another example can be taken from the invention of the wheel. Introduction of the wheel made carrying loads easier (at the locale of the cart and its load) but costs increased elsewhere as domestic animals were needed to pull the carts.

Indeed it might seem as if we could summarize the whole argument of this book in a formal linear manner. This book has had a very linear structure. HT (Chapter 2), TT (Chapter 3), TH (Chapter 4) and HH dependences produce E (Chapter 5) in which humans and things are fitting (Chapter 6). But as conjunctural events occur leading to problems that need fixing (Chapters 7 and 8), fitting solutions are found leading to changes in the overall entanglement. So

$$E + \text{fittingness} + \text{conjunctural event} \Rightarrow \text{problem} \Rightarrow \text{fixing} \Rightarrow \text{selection} \Rightarrow E'$$

I do not present these formulae as laws or rules but as summaries drawn from the arguments presented in this book. They are both logically produced and based on the observation of data. But looking at them more carefully we see the problems involved in simplification and reductionism. In the last formula, the linear structure is cross-cut by the ever present play of entanglements. For example, events do not just occur at random. They are produced within entanglements, as a result of the specific interactions of humans and things. Many things that 'go wrong' are made to go wrong by human conflict and intervention. And whether we think something has gone wrong depends partly on our social positioning. In addition, fixing or problem solving depend very much on the specific entanglement – on what tools are available, on what tools are available to make tools, on the human social relationships and relationships of power that make tools available to certain people, on the human ability to maintain tools and the relationships on which tools depend and so on. There may be dependency constraints that delimit what can be done. Similarly, fittingness is composed of resonance and abstraction that are integral components of entanglements, and it is composed of what humans and things afford each other. What is seen as fitting will depend on social positioning and relations of power. As a result, selection depends on all the components of fittingness within entanglements.

In addition, the whole process occurs at multiple scales simultaneously. Thus the problems caused by the event of a pot breaking in the fire while cooking a lamb stew lead to responses – to repair the pot, or obtain another one or to reduce the temperature in the fire and so on. But these decisions are cross-cut by and intersect with larger processes such as the availability of clay to make pots or the availability of sheep to make lamb stews. And these larger processes are themselves caught within yet larger processes regarding the decision to cook in pots or to domesticate sheep and goat. And they are caught within power relations in whose interest it is to construe an entanglement from a particular perspective; for example I have several times in this book noted how different people, situated in specific ways, construe the entanglement of a thing like a boat (for sailing or leisure or for environmental protection).

So in the end there is no linear sequence. There is simply entanglement with all its conjunctures and temporalities. The reductionism is useful – because it simplifies complex situations and makes them accessible analytically. It allows

one to model what are perceived as essential variables and their interactions. But we also need to explore the full irreducible complexities of human-thing entanglements. These complexities are themselves productive of entanglement (in the generation of bifurcations and conjunctures), and the details do themselves matter. We have seen that small things and little events can have large catalytic effects. There is thus a need to go back and forth, simplifying things and then exploring them in all their multi-dimensional complexities. If the researcher could disentangle an entanglement in order to study the separate strands and how they are wound round each other, then the entanglement would no longer be entangled! There is thus a need to explore entanglement itself, engaging in thick, rich, contextual analysis.

I have at various points in this book suggested that entanglement offers the opportunity for greater quantitative analysis than I have provided here. There is the potential for the analysis of trade-offs based on numerical data derived from experiment, ethnography and scientific knowledge of materials, as in the example provided by Wollstonecroft *et al.* (2008) regarding grinding of foods and described in Chapter 4. This type of quantitative analysis could, for example, usefully be applied to the study of the entanglements around the use of ground stone in the Middle East in Chapter 9. There is much potential for the quantitative analysis of tanglegrams, adapting the suite of techniques used by various forms of evolutionary archaeology and described in Chapter 7. As noted in Chapter 9 there is opportunity for the application of network analysis to the topography of entanglements (Evans, Knappett and Rivers 2007). On the other hand, as already noted, entanglement is a useful concept if it admits to the messiness, indeterminacy and relationality of social life. Entanglement is always historical and specific and these dimensions will always require an interpretive moment. We have seen that the drawing of entanglements depends on goal and perspective. There is a need to explore entanglements from different perspectives, and indeed to situate the different perspectives within higher-level entanglements both of participants and of observers, analysts and interpreters.

Things Again

I wish at the end to return to the definition of things. Throughout this book I have mainly considered material things, mostly hard things made by humans, but also animals, plants and natural materials like clay or water. I have paid scant attention to gases, vapors, smells and sounds although I have discussed music at some length (Chapter 6). In Chapter 1 I included thoughts and feelings as things, even if they pass very quickly and leave no material trace. I argued that things are really flows of matter, energy and information but I have focused largely on those flows that produce hard matter that endures.

Impermanent things can of course endure if translated into some other form, recorded on paper or on tape, memorialized in monuments or stories, or even if simply remembered in the brain. Once translated in this way, evanescent things can become part of entanglements. Humans may give fleeting things (thoughts, feelings) significance and duration; they may invest in them and get entrapped in their intricacies and logics and in their materialization. As argued in Chapter 6, words and ideas and emotions inform the abstractions and resonances that contribute to entanglement. But on their own, ideas, smells, glances, spoken words and thoughts do not have an enduring existence that can act back and create dependency. It is only when translated into some durable form that they do come to be central parts of entanglements.

I have also paid scant attention to institutions as things. I have tended to focus on things that have an object nature rather than on assemblies of people or of complexes of humans and things. These complex things are themselves often translated into or represented by material entities such as buildings, written documents and laws, insignia and the complex practices of interactions between people and things (all those working in a bank and all the flows of financial transactions that make up the bank and so on). The institutions are themselves human-thing entanglements of specific forms as we saw in the discussion of Southwest Airlines in Chapter 6. At a higher level these complex entanglements are things that behave in ways similar to smaller material entities. For example, we depend on them (to look after our money or to transport us to a destination). And they depend on other things (banks depend on computers as do airline companies). And they depend on humans (to maintain them). Entanglement occurs between humans and institutions because complex things have lives and temporalities that are uncertain and draw humans into their care. Humans invest in complex things and so it is in their interests to maintain them. Complex things like Southwest Airlines become selected for if they are fitting in a particular environment.

It seems then that a diversity of types of things can be included within the study of human-thing entanglement, even if I have focused in this book on material entities that have an object nature. Both fleeting, transient events and large-scale institutions have attributes as things that can lead to entanglement and to many of the themes discussed in this book. And as noted in Chapter 1, humans are themselves just complex things with a particular form of life force. As individual humans we depend on other humans, that depend on each other and that depend on us. Other humans fall apart, go wrong and return to dust. As individual humans we become entangled in our debts, duties and obligations to other humans but also in the flows of minerals and organic matter through us. We form dependence, dependency and co-dependency relations with other humans and things that influence the ways in which our lives and our societies unfurl. Like any other thing, the human frame is a transient bounded entity through which matter, energy and information flow, connecting it to other things.

Some Ethical Considerations

I have wanted in this book to retreat from an entirely relational treatment of matter, to rediscover the object nature of things. The thingly relations of things include object relations; materials provide affordances or potentialities to humans. The brute matter of things has effects on us that go beyond social meaning. We cannot reduce things solely to the relational, to a semiotics of things. To do so undermines the power of things to entrap, and particularly to trap the more vulnerable whether these be the victims of the AIDs virus, the work gang bound by chains, the women bound by child rearing, the populations bound by global agricultural systems.

In the modern world, we have come to see that we need to use things sustainably and responsibly, to care for things. But this care and sustainability themselves too frequently involve further management and control, of animals, plants, landscapes, resources and humans. So things have once again trumped us, entrapped us into their care. Whatever different detailed paths we have taken since we emerged as humans, we have as a species become more and more entangled in things. Ever since the first tool and the first fire, ever since we took the path of being dependent on things, we have been caught up in their lives. We have spent all our time as historians detailing the specific paths that have been taken within this broad movement. We have focused on the origins of agriculture and the emergence of property (Rousseau 1755, Marx and Engels 1846), or industrialization and the emergence of the nation state (Hobsbawm 1996, Anderson 1983), or on the emergence of new global technologies (Castells 1996). We have explored how some societies became entangled in guns, germs and steel so that they spread over the Americas (Diamond 1997), or we have explained why, ultimately for geographic reasons, spurts of activity occurred in the west rather than in the east (Morris 2010).

There is much to be done in terms of understanding the different paths we have taken as humans, caught up in our varied ways with things. But the big picture is clear. Since a dependence on made things became an evolutionary pathway, there has been one long movement, initially slow, but speeding up exponentially as the strands of human-thing entanglement lengthened and intensified.

We recognize the dangers, but always with a short-term view. We talk today of sustainable use of the environment, of renewable resources, of green energy, of maintaining biodiversity, of resilient alliances, of recognizing that small is beautiful. We try all these paths but they all have the same effects of increasing input, regulating access, managing and increasing entanglements. These short-term solutions do not look at the big picture, that as humans we are involved in a dance with things that cannot be stopped, since we are only human through things. Perhaps there is a future in expanding our dependence on things into the oceans and into space, although both are increasingly cluttered with our detritus and both would involve vast new inputs and colossal entanglements.

Recognition of the long-term increase in entanglement perhaps raises the stakes in our ethical consideration of the paths we should consider taking as a species. We have tended to deal with the dangers of nuclear accidents, environmental degradation and global warming by proposing regulations and redistributions, which over the long term only seem to increase entanglements. It seems right that we do what we can to save forests, decrease carbon emissions, protect endangered species. It seems right that we individually use less fuel in our cars and put solar panels on our roofs. All these attempts at fixing problems such as global warming conform to the ways in which we as a species have always dealt with problems before. It is in our nature to try and fix our problems now by fiddling and fixing and so becoming more entangled in things and technologies. It is in our very being to devour things. Our bodies incorporate minerals and energies that we gain from things; the electro-chemical activity in our brains depends on food from the world around it; our societies are built on and through things. The environment is not just a backdrop within which we fix problems (Bennett 2010); rather it is actively involved in our being as a species. And this co-dependence, as we have seen, leads ineluctably to dependency and more entanglement. So to fiddle and fix, as we always have done, seems to be the only solution. But we have perhaps come close to the end of the sustainability of this human impulse. Perhaps we need to face the possibility that fixing our technologies of co-dependency only increases rather than resolves the problem. The long term perspective of increased entanglement offered by archaeology and human evolution suggests the need to look deep inside ourselves and into what it means to be human. The moral choice is substantial, to change what it is to be human, to become something other than ourselves.

The Last Thing on my Mind

Although I have discussed a wide range of theory in archaeology in this volume, it has not been my aim to conduct a critical review of theoretical perspectives in the discipline. My reason for considering theories current in the discipline has been to explore whether they can contribute to the understanding and analysis of entanglement. In all the types of theory discussed, it is apparent that new insights can be gained. But I have been fascinated by the extent to which, when considered through the lens of entanglement, supposedly opposed perspectives have complementary parts to play. Of course, I have achieved this synthetic integration by selecting aspects of theories that serve my purpose. For example, I have argued that an evolutionary focus on variation and selection is key to understanding temporal trends in entanglements, but in doing so I have had to argue against the common emphases in evolutionary archaeology on transmission and reproductive success. Similarly, Human Behavioral Ecology is of great value in analyzing the cost-benefit trade-offs within entanglements, but only if the reductionism so

valued within that approach is redressed and if costs and benefits are redefined so as to include the disruptions and contributions to heterogeneous entanglements (including the resonances and abstractions in which humans get caught).

Every scheme has its limits. Tang (2010) argues that however much theories in the social sciences aim to be comprehensive there is always something left over, some awkwardness where the theory does not quite work, or some gaps that are left unaddressed. In many ways entanglement does seem to me to be a neat scheme. It avoids the twin dangers of materialism and idealism, objectivism and subjectivism; it allows a more nuanced approach to colonial and post-colonial processes since it is less absorbed by domination and resistance; similarly it incorporates agency (in fixing problems and finding solutions) while at the same time de-centering the human in social life; it allows an emphasis on the immediate and short term but embedded within long-term evolutionary trajectories; it allows directionality without teleology. I am attracted to it because, as shown in Chapter 9, it opens up fruitful forms of analysis that can be carried out on archaeological data and that have developed from existing and specifically archaeological approaches (for example, operational chains, type sequences, behavioral mapping). Perhaps most important, it bridges between culture and biology, inserting a third term, the material, that forces a blurring of the boundaries between our biological, evolutionary nature and our culture.

But in this conclusion I have had to do some mopping up, dealing with the things left over or left out by the entanglement scheme, the inelegancies, the contradictions. I have pointed to the relative lack of focus on HH dependences and on power and agency. I have also noted the tensions between objective entanglement (as seen in a tanglegram) and positioned or situated interest; evaluating whether things go wrong involves socially positioned decisions. I have discussed the tensions between reductive clarifications and the full complexities of human-thing interactions, between quantification and contextual interpretation. I have noted problems in the definition of thing itself.

But in the end perhaps the main attraction of entanglement, ironically its main neatness, is its messiness. Entanglement is about being caught up in real things in specific conjunctural ways that come about through complex interactions. It is not bounded, schematic, theoretical. It describes the ways in which we live our lives struggling between webs of demand and potential, making do, working it out, unclear what is happening much of the time, not knowing the results of our actions or why. We can never mop up all this mess.

It is always difficult to end a book. The book has a beginning and an end and one wants to tie up all the loose ends before finishing. But the loose ends can never be neatly tied up – if they could it would be possible for there to be an end to entanglement. But humans cannot exist without things. And things, or at least this is my argument, cannot be wholly subjectified into humans. So the loose ends cannot be tied up and entanglement continues, well beyond the neat bounds of this book.

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